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HOT TECHNOLOGIES: LOOKING AHEAD TO 2012

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Hot 100 Products of 2011

Page 31

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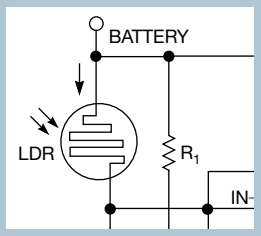
Hot technologies: looking ahead to 2012

Hot 100 Products of 2011

IMAGE(S): THINKSTOCK

DESIGNIDEAS



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DEPARTMENTS & COLUMNS

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EDN online

JOIN THE CONVERSATION

Comments, thoughts, and opinions shared by *EDN*'s community

In response to "Ham radio in the 21st century," by Doug Grant, K1DG, at http://bit.ly/rvBolE, Pete Flynn, K5BCG, commented:

"For me, the best thing about ham radio is the potential simplicity of the hobby. Considering that the basics were developed with a very-low-tech, 19th-century approach, the nontechnical person can get involved and have fun building stuff that works. Most of the technical people in the hobby enjoy helping new people and can get you through the more complicated bits. This is a wonderful hobby for anyone who appreciates technology and wants to dabble."

In response to "Teardown of ViewSonic gTablet: Unleashing the power of Tegra-2," a blog post by Patrick Mannion at http://bit.ly/tDkhVD, and also available in this issue's Prying Eyes column on pg 26, Derek Appleton commented:

"The only negative comment I have about the gTablet is the buttons and touch capability. There should be a two-touch system where you must hold one button while selecting either a soft-touch button or a side-located button. I use the tablet with the Kindle Reader and am always either changing page accidentally or jumping to an unwanted location. A two-button system would solve this [problem]."

EDN *invites all of its readers to constructively and creatively comment on our content. You'll find the opportunity to do so at the bottom of each article and blog post. To review current comment threads on EDN.com, visit http://bit.ly/EDN_Talkback.*

CONTENT

Can't-miss content on EDN.com

LED WREATH INCORPORATES DAYLIGHT HARVESTING

In this how-to blog post, *EDN*'s Margery Conner shares simple instructions for a solar-powered LED Christmas wreath. Martha Stewart-like craft skills are not required for this smart and energy-conscious holiday decoration.

http://bit.ly/sRFhxL

MEDICAL SENSORS IN BIOMEDICAL ELECTRONICS, PART 2: THE BRAIN, HEART, AND LUNGS

In this follow-on to *EDN*'s December 1, 2011, cover story, Steve Taranovich looks at how people suffering from brain, heart, and lung deficiencies benefit from a collaboration of electronic, biological, and medical technologies in the 21st century.

http://bit.ly/sGlcu8

ENGINEERING COMMUNITY

Opportunities to get involved and show your smarts

ACE AWARDS EE Times EDN

INNOVATORS ARE ACES IN OUR BOOK *New this year,* EDN*'s Innovation Awards and* EE Times*' ACE (Annual Creativity in Electronics) Awards are joining forces to honor the people and companies behind the technologies and products that are changing the world of electronics and shaping the way we work, live, and play. The 2012 UBM Electronics ACE Awards will showcase the best of the best in today's electronics industry, including the hottest new products, start-up companies, design teams, and executives. Find out more and submit entries at http://ubm-ace.com. Hurry; the deadline for nominations is Jan 6. Awards will be presented during ESC Silicon Valley, March 27, in San Jose, CA.*

EDN

BY PATRICK MANNION, DIRECTOR OF CONTENT

The real technology companies

Those who blithely declare that Facebook versus Google or Amazon versus eBay are the big technology battlegrounds should probably avoid reading this issue because it may only blur their otherwise-clean definitions of what technology is. Wall Street, like engineers, doesn't like blurry lines.

As an engineer, I find it easy to look at the Hot 100 Products (pg 31) and say definitively that these products represent the best technology had to offer in 2011. Why? Because they do! From Analog Devices' ADA4096-2 dual op amp to Tektronix's MDO4000 mixed-domain oscilloscope, all represent the latest thinking in integration, processing, end-user requirements, cost, features, power, and so on. The products were designed *by* real engineers *for* real engineers.

In the Hot Technologies section (pg 34), our editors outline what those real engineers are now enabling with those products and looking into 2012. Contributing Editor Steve Taranovich takes a future-is-now approach to medical implants, pointing to Cactus Semiconductor Inc's neurostimulation, pacing, defibrillation, ultrasound, and medical-monitoring technology, as well as Plessey's EPIC (electric-potential integrated circuit), which can detect changes through clothing—and even through walls. EPIC proves once again that we have not yet reached the limits of what we can measure and detect, and that's exciting!

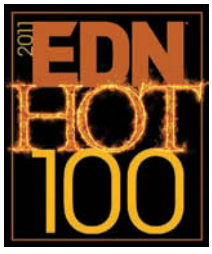
Along the test theme, *Test & Measurement World*'s Martin Rowe describes mobile apps from Oscium and a wireless digital-multimeter app from Redfish Instruments that turn your iPad or Android device into an ultraportable, ultraflexible iTest platform.

You'll find much more in which to immerse yourself if you'd like to get a quick update on what's happening beyond your specific field of interest—if you're lucky enough to be able to indulge in a specific field of interest. Margery Conner and Bill Schweber give the latest on, you guessed it, LEDs and LED drivers. You had better pay attention: 2012 will be a big year for LEDs in the United States as the federal government begins to phase out inefficient light sources.

Janine Love provides an update on low-power wireless, which will be everywhere in the coming year, and Clive Maxfield updates us on programmable logic. The GreenPak 2 from Silego is particularly exciting. I hope the company takes the time to enter it in our UBM Electronics ACE Awards (www.ubm-ace.com), as should others from the Hot 100 Products list. Check to see whether your devices are on it and take a stab at the awards.

Finally, Rick DeMeis gives the latest in automotive innovation, Rich Pell provides an audio download, Colin Holland shows us what's hot in microcontrollers, and Paul Rako tells us why PCBs are hotter than you'd think.

All in all, it's an issue I'm particularly excited about, and I hope you are too. However, sitting here looking at the cover for the October issue of *Test & Measurement World*, I can't help but surmise that anyone who tries to separate technology from the application of technology is in for a rough ride. The cover features a smiling Ward Ramsdell, electrical engineer and co-owner of Prototype Engineering, sitting at a bench strewn with high-end test equipment. He's posing for a photo and looks busy testing something, but it reminds us that the components now in test systems will enable the development of the next generation of components and systems.



As an engineer, I find it easy to look at the Hot 100 Products and say definitively that they represent the best technology had to offer in 2011, because they do!

In the same way, those systems in data centers will allow Google, eBay, Amazon, and Facebook to develop the next generation of applications and interaction channels that will enable the communications and collaboration that will, in turn, enable the next generation of systems design. So, are Amazon, Facebook, eBay, and Google good technology companies or good applications-of-technology companies?

You could ask the same of Apple. The iPod and iPhone were and are not new technologies but good packaging of fairly standard technologies. Where do real engineers sit in this landscape? It's a blurry line indeed. Can you help me get a clean eye diagram on this? In the meantime, enjoy the products and tools of your endeavors, and read on. EDN

Contact me at patrick.mannion@ubm.com.

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INNOVATIONS & INNOVATORS

HB-LED-driver chip set provides dimming, PFC

A chip-set pair from On Semiconductor provides high-efficiency, HB (high-brightness)-LED drive and dimming. The multistage, resonant, half-bridge NCL30051 LED driver delivers a constant voltage to a step-down dc/dc converter/LED driver, such as the NCL30160. The device, which combines a critical-conduction mode, a PFC controller, and a half-bridge resonant controller with a built-in 600V driver, targets use in offline power supplies.

The NCL30051's half-bridge stage operates at a fixed frequency. You achieve regulation by adjusting the PFC-stage output voltage. The device integrates open feedback-loop protection, plus PFC overvoltage- and undervoltage-detection mechanisms, as well as an adjustable-frequency oscillator, which can be set at frequencies as high as 75 kHz.

The dimmable, constant-current, step-down buck NCL30160 LED driver for high-power LEDs steps down the voltage from the NCL30051-enabled power supply to provide a constant current across the LED string. It provides as much as 98% efficiency using an internal, 55-mΩ-on-resistance MOSFET, and it can operate at a 100% duty cycle.

The device operates with an input voltage of 6.3 to 40V, which suits it for use in industrial and automotive applications. Switching frequencies as high as 1.4 MHz allow the use of small external components, helping to minimize board size and cost.

The hysteretic control of the NCL30160 provides fast response during load transients and eliminates the need for small-signal control-loop-compensation components. Protection features include resistor-programmed LED current, shorted-LED protection, undervoltage lockout, and thermal shutdown.

Both the NCL30051 and the NCL30160 have operating-junction-temperature ranges of –40 to +125°C. The NCL30160 comes in an SOIC-8 package, and the NCL30051 comes in an SOIC-16 package.

—by Bill Schweber

▷**On Semiconductor**, www.onsemi.com.

The NCL30051/NCL30160 chip set provides high-efficiency, HB-LED drive, PFC, and dimming.

TALKBACK

"After a career in the electronics industry, I now have the time to really dive into the hobby even deeper, working with … technologies I worked with in the industry. It is much more fun to do design and construction the way you want to do it instead of the way management and marketing want it done."

—Retired electronics-system engineer William Bowen, in *EDN*'s Talkback section, at http://bit.ly/rvBolE. Add your comments.

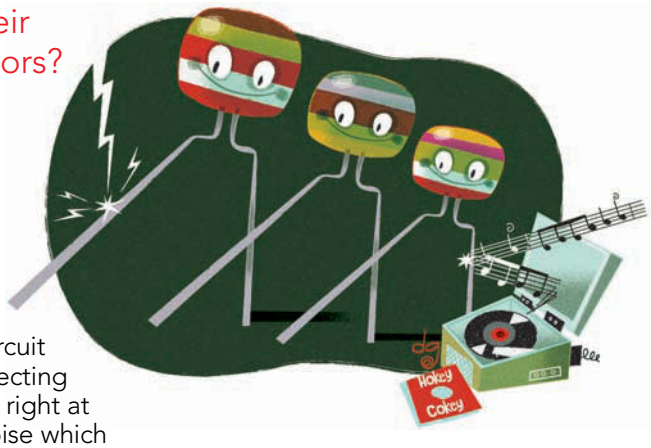
RAQ's

Rarely Asked Questions

Strange stories from the call logs of Analog Devices

In and Out – or – Why Have a Capacitor?

Q. Why do ICs need their own decoupling capacitors?



A. To keep the HF in and the HF out. (This is not a claim that capacitors dance the Hokey Cokey.)

There are two important reasons why every integrated circuit (IC) must have a capacitor connecting every power terminal to ground right at the device: to protect it from noise which may affect its performance, and to prevent it from transmitting noise which may affect the performance of other circuits.

Power lines acting as antennas can pick up high-frequency (HF) noise, which can couple by electric fields, magnetic fields, electromagnetic fields, and direct conduction from elsewhere in the system. The performance of many circuits is impaired by the presence of HF noise on their supplies, so any HF noise which might be present on an IC's supply must be shorted to ground. We cannot use a conductor for this as it will short circuit dc and blow fuses, but a capacitor (usually in the 1-nF to 100-nF range) blocks dc while acting as a short circuit for HF.

1 cm of wire or PC track has ~8 nH inductance (5 Ω at 100 MHz), which is scarcely a short circuit. A capacitor acting as an HF short circuit must have low lead and PC track inductance, so each supply capacitor must be located very close to the two terminals of the IC it is decoupling. It is also important to choose capacitors with low internal inductance—usually ceramic ones.

Many ICs contain circuitry which generates HF noise on their supply. This noise must also be short circuited by a capacitor across the supply before it can corrupt other parts of the system. Again, the length of leads and PC tracks is critical; not only do long leads act as inductances and make the short circuit less than perfect, but long conductors act as antennas, transmitting HF noise to other parts of the system by means of electric fields, magnetic fields, and electromagnetic radiation.

It is therefore very important that every supply terminal of every IC should be connected to its ground terminal (or terminals, which must all be joined together with broad, low inductance PC tracks so that there is no resistance or inductance to prevent them all behaving as a single low-impedance unipotential star point) with a very low inductance capacitor.

To Learn More About Decoupling Capacitors
http://dn.hotims.com/34953-100

Contributing Writer James Bryant has been a European Applications Manager with Analog Devices since 1982. He holds a degree in Physics and Philosophy from the University of Leeds. He is also C.Eng., Eur. Eng., MIEE, and an FBIS. In addition to his passion for engineering, James is a radio ham and holds the call sign G4CLF.

Have a question involving a perplexing or unusual analog problem? Submit your question to: www.analog.com/askjames

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Wireless telemetry monitors dragonflies at the neuron level

Dragonflies combine delicate horizontal and vertical maneuvering to capture their prey in midflight, intriguing scientists at HHMI (Howard Hughes Medical Institute), who want to better understand the insects' complex flight-control system. The HHMI researchers gather information by attaching tiny electrodes to cells in the dragonflies' neural cord and recording the electrical activity of the neurons and muscles. Instrumenting and gathering the electrical data are problems, though, because systems to perform these tasks are heavy. As a result, researchers to date have performed experiments with immobilized dragonflies, hardly an accurate model of how dragonflies actually move within their environment.

To address these problems, Matt Reynolds, an assistant professor of electrical and computer engineering at Duke's Pratt School of Engineering, leads a team of electrical engineers, who developed a wirelessly powered, lightweight, and powerful telemetry system that allows scientists to study the neurological activity of dragonflies as they capture prey. The new system uses no batteries; it wirelessly beams power to flying dragonflies. The wireless power transmitter works within a "flight arena" for the experiments; it has nature scenes on the walls, a pond, and fruit flies for the dragonflies to chase and eat. The plan is ultimately to sync the neuronal data from the chip with high-speed video while the insects are in flight and preying on fruit flies.

Researchers at Duke University have developed a wirelessly powered, lightweight, and powerful telemetry system that allows scientists to study the neurological activity of dragonflies as they capture prey. You can just barely see the threadlike antenna end hanging down on the right.

"The average weight of the dragonfly species involved in these studies is about 400 mg, and … an individual dragonfly can carry about one-third of its weight without negatively impacting its ability to fly and hunt," says Reynolds. Most multichannel wireless-telemetry systems now weigh 75 and 150 times more than a dragonfly, not counting the weight of the battery, which rules them out for most insect studies. "[An older] battery-powered version of the insect-telemetry system … weighs 130 mg—liftable by a foraging dragonfly but with difficulty," he adds.

The telemetry system uses a custom IC that Reynolds and his team developed. It uses the same wireless power source to return data at rates greater than 5 Mbps. The chip weighs 38 mg, less than half the weight of a postage stamp. Sporting two hair-thin antennas, the chip attaches to the dragonfly's belly and out of the way of its wings.

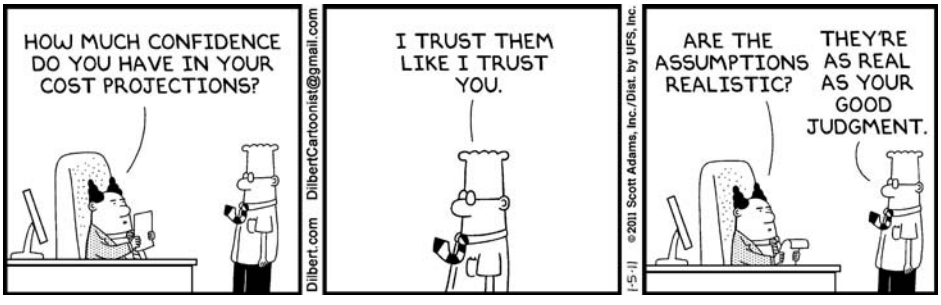
Reynolds recently presented his work at the IEEE's annual Biomedical Circuits and Systems Conference in San Diego. According to Reynolds, the same antenna provides power to the chip and returns data back to a base station. He claims that the telemetry chip consumes only 1.23 mW in operation, including the neural and electromyography-signal amplifiers, analog-to-digital conversion, and data transmission at a continuous rate of 5 Mbps.

A 4W transmitter sends power to the chip, which has a power-up range of as much as 5m, or approximately 15 feet. Although a higher-power transmitter would result in a larger power-up range, the researchers are considering an indoor-flight arena to eliminate the need for larger ranges. The researchers implemented the low-power communication link with modulated backscatter, similar to that of an RFID tag. None of the standard protocols, such as Bluetooth or 802.11, support this means of communication because they do not target use in neural telemetry. So the researchers had to engineer their own streaming protocol for the telemetry data. They achieved a power-efficient communication link with an energy consumption of only 4 pJ per bit—an impressive benchmark to shoot for in wireless sensor networks and a practical demonstration of RF-wireless-power transfer.

—by Margery Conner

▷**Howard Hughes Medical Institute**, www.hhmi.org.

DILBERT By Scott Adams



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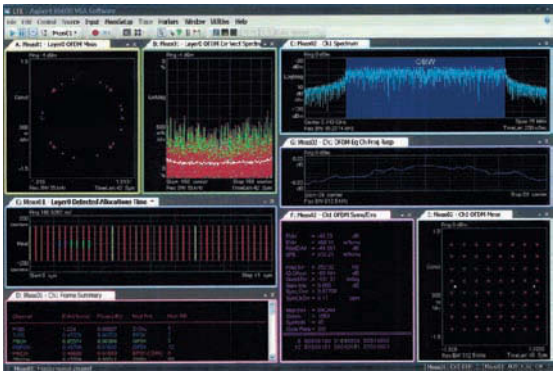
Multimeasurement enhances VSA software

Agilent Technologies Inc is adding a multimeasurement capability to its 89600 VSA (vector-signal-analysis) software, enabling simultaneous signal analysis of multiple carriers and signal formats for more efficient testing and deeper signal insight in wireless testing. The 89600 VSA software's multimeasurement capability provides the power of multiple signal analyzers using one user interface. The software's architecture enables engineers to simultaneously configure multiple measurements.

All measurements reside in memory, so you can call on any or all of them for immediate and coordinated execution. The product lets you perform measurements sequentially when signals are too far apart for one acquisition to capture. The software then displays the results on one screen, so that users can employ trace overlays and user-defined equations to do in-depth comparisons.



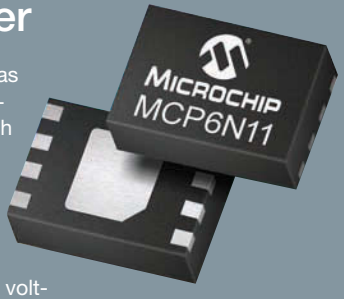
Agilent's 89600 VSA's multimeasurement capability displays the results on one screen, so that users can employ trace overlays and user-defined equations to do in-depth comparisons.

"The success of our wireless-[system] customers depends heavily on their ability to keep pace with rapidly evolving technologies and standards," says Guy Séné, vice president and general manager of Agilent's microwave and communications division. "By adding multimeasurement capability to our 89600 VSA software, which supports a wide variety of Agilent instruments, we will be providing ... flexible multimeasurement … that enables engineers to see through the complexity in their wireless designs."

The feature will find use in a variety of test scenarios, including MSR (multistandard radio). Along with its recently announced MSR-measurement application for X series signal analyzers, Agilent now has a range of test products supporting the product life cycle of the MSR base station from R&D through manufacturing.

The 89600 VSA software provides general-purpose and standards-based tools for evaluating signal spectra, modulation, and time characteristics and enables troubleshooting of physical-layer signal problems. This software is compatible with more than 30 Agilent signal analyzers, oscilloscopes, and logic analyzers, and it runs on Microsoft Windows-based PCs or in PC-based instruments. The capability will be available as a standard feature of Agilent's 89600 VSA software. **—by Colin Holland**
▷**Agilent Technologies**, www.agilent.com.

Instrumentation-amp arena gets a new player



Microchip Technology has entered the instrumentation-amplifier market with the MCP6N11, which features the company's proprietary mCal technology. The on-chip mCal calibration circuit enables low initial-offset voltage and a means to control offset drift.

When an op amp just doesn't suffice for critical sensor signal conditioning and interfacing, you need an instrumentation amplifier, which can reject common-mode noise and extract tiny signals despite the presence of far larger signals and power-supply imperfections—even 100 dB.

Relatively few analog-IC vendors make instrumentation amps, but the supplier list has a new entry: Microchip Technology, whose MCP6N11 features the company's proprietary mCal technology. The on-chip mCal calibration circuit enables low initial-offset voltage and a means to control offset drift, which results in higher accuracy across time and temperature—both factors that can seriously harm instrumentation-amp system-level performance.

The device uses CMOS process technology for low power consumption and provides a gain-bandwidth product of 500 kHz. It features a hardware-shutdown pin for even more power savings. The device's 1.8V operation allows two 1.5V batteries to drain beyond typical use, and its rail-to-rail input and output operation enables full-range use, even in low-supply conditions.

Two user-supplied external resistors set a gain of 1, 2, 5, 10, or 100V/V. At a gain of 100, the CMRR (common-mode-rejection ratio) is typically 100 dB and can be as high as 115 dB, and the PSRR (power-supply-rejection ratio) is 112 dB. Supply current is typically 800 µA, and the device operates from a supply of 1.8 to 5.5V. It operates over a –40 to +125°C temperature range.

The MCP6N11 instrumentation amplifier is available in eight-pin SOIC and eight-pin, 2×3-mm TDFN packages for $1 (10,000). The $34.99 Wheatstone-bridge reference design is also available.—by Bill Schweber
▶**Microchip Technology**, www.microchip.com.

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Four-channel, handheld, battery-powered DSOs boast 5G-sample/sec acquisition

Tektronix has introduced the THS3000 series of 100- and 200-MHz-bandwidth, four-channel, handheld, battery-powered, isolated-input DSOs, whose technology and packaging owe much to sister company Fluke's similarly priced 190-II-200 series of isolated-input four-channel ScopeMeters. The instruments in both families run continuously for seven hours on a charge, and you can recharge the battery inside or outside the instrument.

Tektronix considers the THS3000s to be scopes rather than combination scopes/DMMs, as in Fluke's case. The Tek and Fluke user interfaces differ somewhat, and, in the single-channel mode, Tek's top-of-the-line THS3024 takes twice as many samples per unit time—a maximum of 5G samples/sec—as does Fluke's 190-II-204. Fluke and Tektronix also have different approaches to the software with which their customers are likely to use the instruments. Fluke's base prices are a bit lower than Tek's, but Fluke charges extra for its FlukeView software. Tektronix includes its Open Choice software with the instruments, thereby reducing the price differential.

Neither family offers deep waveform memory. Memory depth is 10,000 points except in roll mode, in which it triples to 30,000 points. At 5G samples/sec, 10,000 points represents just 2 µsec. You can, however, automatically capture portfolios of similar waveforms that meet criteria you specify and observe how they have changed over time.

The scopes have four front ends—one for each channel. Each front end includes its own signal-sampling circuit. Single-channel mode dedicates all four front ends to the one active channel. Sampling is staggered so that the time between successive samples is equal. Two-channel mode connects front ends 1 and 3 to one channel and front ends 2 and 4 to the other, so that the sampling rate on each channel is half the maximum. In four-channel mode, each channel connects to its own front end. The scope samples the four channels in sequence—not simultaneously.

Although the Tektronix and Fluke units comply with different safety specifications, both provide ohmic isolation among all four channels, between each channel and the instrument case, and between the USB ports and the case. Any sort of ohmic isolation is unusual in scopes, but such complete isolation and Tek's compliance with Category III specifications are even rarer.

The THS3024 four-channel, handheld DSO boasts 200-MHz bandwidth, 5G-sample/sec acquisition, seven hours of continuous operation from its rechargeable battery, and, for operator safety and accuracy, some of the industry's most complete ohmic isolation.

The units include both USB-host and USB-device ports, through which you can save captured data and control external peripheral devices. US suggested retail prices begin at $3950. Tek offers a broad line of THS3000 probes, including insulated units for operator safety when probing high voltages. Other accessories include an external battery charger and soft- and hard-sided carrying cases.

—by Dan Strassberg

▷**Tektronix Inc**, www.tektronix.com.

Thin, low-ESR, electrical, double-layer capacitors debut

Murata Electronics North America has announced the DMD and DME series of thin, low-resistance electrical double-layer capacitors, or supercapacitors. The devices lack traditional dielectric layers, instead storing charge in an electrical double layer at the solid-liquid interface. The parts feature a peak voltage of 2.7V per cell and 30-mΩ ESR at 1 kHz, as well as stable output characteristics over an operating-temperature range of –30 to +70°C. According to Murata, the devices offer higher energy storage and power density than do conventional capacitor technologies.

The DMD and DME series of supercapacitors target use in LED flash, audio circuits, and power amplifiers.

The DMD and DME series work in applications requiring burst or pulse loads, such as LED flash, audio circuits, and power amplifiers. The ability to deliver peak-current assistance to the load gives the devices longer battery life between charges, and the devices provide maintenance-free power storage with a useful life exceeding 100,000 cycles. The DMD and DME series can also operate in nonportable equipment for applications ranging from backup to pulse transmission for solid-state drives, smart meters, and industrial systems.

The supercapacitors are available in 2.7 and 5.5V options, measuring 20.5×18.5×1.5 mm, with a 700-mF value. The 5.5V double cell comes in a 20.5×18.5×3-mm package in a 350-mF value. Sample prices for the 2.7V, 700-mF option are $4; the 5.5V, 350-mF option costs $6.50.

—by Ismini Scouras

▷**Murata Electronics North America**, www.murata-northamerica.com.

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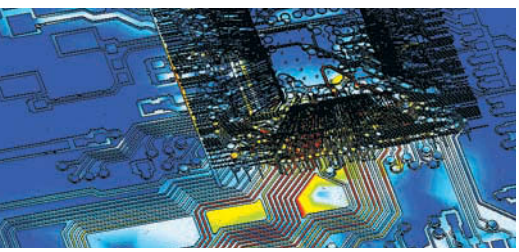

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After I bought a Kindle, I could throw an entire library in my backpack and read anywhere, anytime, and anything from my Kindle account—anything, that is, except for books with tables, books with graphics, books with equations, and books with photos. It turns out that publishers of nonfiction don't format their books with e-books in mind, and anything that is not text can show up in a weird format. It doesn't have to be that way, but print publishers don't care what it looks like on a Kindle. So the old Kindle is great for reading books that are all text, which is 99% of fiction, and lots of nonfiction, such as Michael Lewis' *Moneyball: The Art of Winning an Unfair Game*.

When I heard about the Kindle Fire with its high-resolution, active-color touchscreen, it piqued my interest. I ordered one in the hope that it would be the one reader that would suit all of the reading that I do—magazines, newspapers, nonfiction, and fiction—and maybe even handle pictures, videos, and music. I'm not particularly interested in Web access and interaction. I'm happy with my laptop, especially with the plethora of USB connectors on my work's Thinkpad and the lightness and versatility of my home Mac Air. There are times, however, when access to the Web while reading would be nice, such as when I need to decipher an unfamiliar word or phrase.

When the Kindle Fire arrived, I immediately charged it and then went straight to my Kindle library and opened up an e-book that's brimming with screenshots that I couldn't decipher with my old Kindle. I could actually read them. In addition, it advances multiple pages like lightning; the old Kindle relies on a button outside the screen to fairly slowly advance.

The Kindle Fire has a 6-in., high-resolution color touch display, a Web browser, and eight-hour battery life.

Although the Fire's fast paging is a delight, I've discovered that the device sometimes doesn't respond when I tap to "turn the page" in an e-book. I've read about this problem elsewhere, so I don't think it's due to my tapping style. To fix it, you tap twice or even tap and follow with a swipe, and all is well. It's not a deal-breaker for me.

You may have read that Amazon is selling the Kindle Fire at a discount. Jeff Bezos, in his wisdom, figures that it's worth subsidizing customers about $5 to get what is, in another light, an Amazon catalog in their hands. Since I bought my first Kindle, I have purchased on impulse a lot of e-books, and I'm sure it will only get worse with the Fire.

I currently subscribe to the print versions of several magazines, including *Wired*, *The Atlantic Monthly*, *The Economist*, *Smithsonian*, and *Make*. To add them to my Kindle Fire would cost $2.99 a month for *The Atlantic*, $9.99 a month for *The Economist*, and $1.99 a month for *Smithsonian*. Kindle's *Wired* comes free with a print subscription or $1.99 a month without one, and Kindle doesn't list *Make*. At those prices, I won't soon be adding those subscriptions.

As for books, my local library—and probably yours, too—is a member of the Overdrive system, allowing me free downloads of library books on my Kindle, just as I would check out a printed book. Amazon also recently announced that it would lend free books to its Amazon Prime members. However, the person in whose name the Kindle is registered must also be the name on the Prime account. So if your spouse's name is on the Prime account and your name is on the Kindle, go fish.

Also on the downside, Kindle Fire, at 14 oz, is twice as heavy as my good ol' Kindle, and the Fire's active screen has only an eight-hour battery life, versus months with my old Kindle. Nevertheless, Kindle Fire is a lovely uber-e-book reader and a lovely Amazon-catalog platform. Print publishers are still figuring out their pricing and are doubtless doing some kind of dance with Amazon's cut, but this situation will affect their business as surely as the iPod affected the music business.

The bottom line? Would I buy the Kindle Fire again? Yes.

—by Margery Conner

▷**Kindle Fire**, www.amazon.com.

EFFICIENT P-CHANNEL MOSFET COMES IN A SMALL PACKAGE

12.15.11

Available in a compact and thermally efficient DFN1616 package, the 12V DMP1245UFCL P-channel enhancement-mode MOSFET from Diodes targets battery-powered applications in which runtime and overall life are critical factors. The 29-mΩ on-resistance at a 4.5V gate-to-source voltage is 15% better than that of available competitive units, according to the vendor. The manufacturer also claims that the device's off-board profile of 0.5 mm is 20% thinner than competing equivalents and that it occupies a PCB area of just 2.56 mm², which is 55% that of alternative 2×2-mm packages. The device specifies 3-kV gate protection against ESD. The MOSFET sells for 15 cents (3000).

—by Bill Schweber

▷**Diodes Inc**, www.diodes.com.

The DMP1245UFCL P-channel MOSFET has 15% better on-resistance than competing units, according to the vendor.

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VOICES

Bill McClean: Don't broad-brush the semiconductor market

Bill McClean, president of market-research company IC Insights, spoke to *EDN* in November on 2011's estimated semiconductor-industry growth, expectations for 2012, and why the always-complex semiconductor market cannot be judged on just one of its aspects. Excerpts of that conversation follow. Read the complete interview at www.edn.com/111215pulsea.

2011 started off great, full of optimism and high growth expectations for the semiconductor industry. But that mellowed as the year progressed, and now, as 2011 comes to a close, recent estimates call for low-single-digit growth, which could appear meager compared with previous estimates for double-digit growth. What's your take on that?

A We have the total semiconductor market at 2% [growth] for this year. At the beginning of the year, we were at about 10%. A few things came along and hurt that higher scenario. One was all of the uprisings in the Arab world that served to raise oil prices. Our original forecast for the worldwide economy GDP growth was 3.9%, and it looks like it is going to come in at 3.3%. That [fact] is really the key to why the semiconductor market did not do better. Of course, there was the tsunami in Japan that disrupted the supply chain and created additional uncertainty out there. The US debt-ceiling fiasco this summer and the ongoing situation in Europe [created] more uncertainty.

We've always said that uncertainty is the worst thing in the marketplace. It's actually worse than bad news. If you know something is going to be bad, you can plan around it. But uncertainty creates total fear and total apprehension, and it makes people freeze. They don't do anything; they just sit on the sidelines. 2011 saw a tremendous amount of uncertainty, and that [feeling] showed up in the semiconductor market.

Were there any areas of the market that did not do as well as expected in 2011?

A One of the key areas that really took a beating this year was the DRAM market, going down 25% this year. If you look at the semiconductor market without DRAM, market growth would be close to 6% [for 2011]. Prices are starting to firm up in the DRAM market, which is a good sign going into 2012. The oversupply is likely to be gone. In general, there was an inventory issue [across the IC market in 2011]. … We see the IC market going into next year in somewhat of a steady state—not excess inventory

[and] not a shortage of capacity. Our view for 2012 is really dependent on what the worldwide economy does, and our forecast for next year is 3.5% growth for worldwide GDP. Given that [situation], we are looking at a 7% increase for the semiconductor market next year. It's pretty tied to what happens in the worldwide economy.

Going back to 2011, overall we may be looking at 2% growth, but there are semiconductor-industry companies that will outdo that. Companies on the IC Insights Top 20 list would show 6% growth if examined exclusively. Were there any markets that really shone in 2011?

A The smartphone is going to increase 63% in units this year, and that [growth] was after a 64% increase last year. The smartphone market takes a lot of flash memory. The NAND flash market is doing pretty well this year. We have it going up 13% this year. Application processors that go into cell phones are doing very well this year. That market is going up more than 20%.

The microprocessor market is doing pretty well because average selling prices are holding up. The microprocessor market [should] be up 15% this year. Unit volume is up only 4%, but the average selling price is up 10%. The pricing for some of these microprocessors going into servers and even in some PCs is firm, and some have increased.

You definitely don't want to broad-brush the entire market with a 2% brush because, as the Top 20 list shows, there are wild swings, [and] there are double-digit growth rates and double-digit declines.

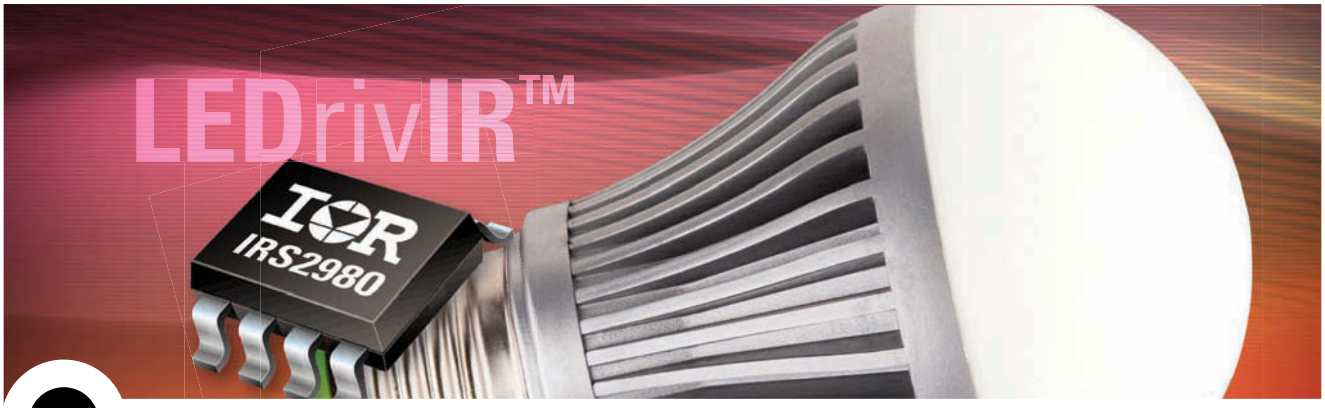
As we conclude 2011 and move toward 2012, how do you feel overall? Are we happy with 2% growth?

A Overall, it could have been better. There were a lot of things that conspired to create the low growth. We were really looking for a much better market this year. Given this state of the world economy, it's holding its own and doing as well as can be expected.

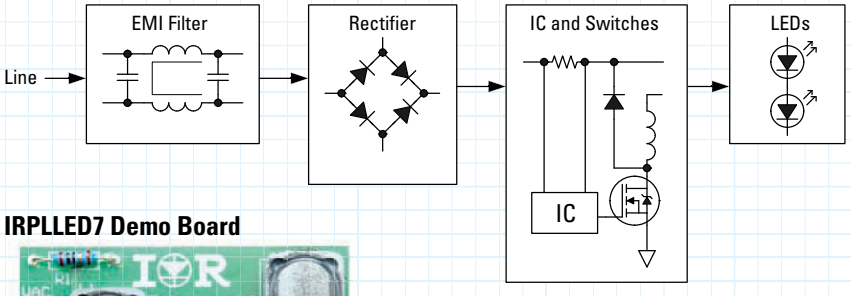
Going into 2012, there's not a lot of optimism. Most forecasts are around ours for GDP, but, again, those are forecasts. We started out last year with a lot of people pretty optimistic, so [2012] could go the other way, as well.

In the US economy, there's 9% unemployment now, but what really matters to the economy is how the other 91% feel. If they have a scared attitude, an uncertain attitude, it is not going to do very well. If they feel confident, if the unemployment rate goes down and people start to say that it's getting better or not getting worse, … people will get off the fence. Once things start turning, purchases can do better than [estimates]. There's some hope. Growth in the mid- to high-single digits is still very doable next year, even given the mediocre outlook.

—interview conducted and edited by Suzanne Deffree



High-Voltage Buck Control ICs for Constant LED Current Regulation



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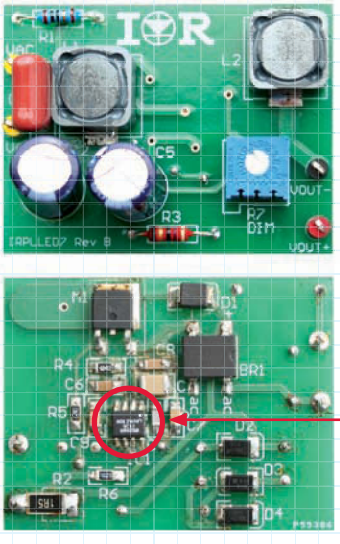

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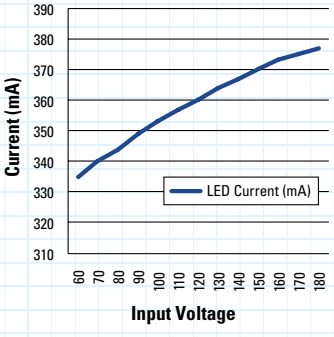
LED Current vs Input Voltage



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Part Number	Package	Voltage	Load Current Regulation	Startup Current	Frequency
IRS2980S	SO-8	600V	+/-5%	<250 µA	<150 kHz
IRS25401S	SO-8	200V	+/-5%	<500 µA	<500 kHz
IRS25411S	SO-8	600V	+/-5%	<500 µA	<500 kHz

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BY BONNIE BAKER

Designing with temperature sensors, part four: thermocouples

Thermocouples offer distinct advantages over other temperature sensors, such as thermistors, RTDs (resistance-temperature detectors), and silicon sensors. Thermocouples respond to the widest temperature range. Different environment requirements, such as vibration resistance or corrosion resistance, can help determine the correct thermocouple type for your application.

You can construct a thermocouple with two wires of dissimilar metals or alloys, such as iron and constantan (Type J). A weld bead bonds the two dissimilar metals on one end of both wires. If there is a temperature difference between the bead and the open end of the thermocouple wires, an EMF (electromotive-force) voltage appears between the open end of the two wires. This EMF voltage changes proportionally with temperature without voltage or current excitation. The temperature range of the thermocouples may vary depending on the types of metals being used. **Table 1**, available with the Web version of this article at www.edn.com/111215bb, presents types of thermocouples whose temperature ranges vary, depending on the types of metals used. The Seebeck coefficient is the first derivative of the thermocouple's EMF voltage as a function of temperature.

Thermocouples produce a voltage that ranges from a few microvolts to tens of millivolts. This voltage is repeatable but nonlinear through changes in temperature. Because all thermocouples are nonlinear, the value of this Seebeck coefficient changes with temperature. To account for this nonlinearity, designers typically use look-up tables in their microcontrollers or processors.

Figure 1 shows an example of a single-supply thermocouple application using a J-type thermocouple. The J-type thermocouple wires are soldered to the PCB copper, which creates thermocouples J_2 and J_3.

In any thermocouple application, the variables at work are the EMF voltage change versus the temperature of the thermocouple's bead versus the open-ended wires, the absolute temperature at the near site (B), and the absolute temperature at the far site (A). The thermocouple manufacturer provides a table of the EMF voltage versus temperature for the thermocouple bead. This information leaves two unknowns: the temperature at A and the temperature at B. In finding the temperature at site B, the isothermal block in **Figure 1** is a plane that contains J_2, J_3, and the temperature sensor, which is inside the ADS1118 chip. The accuracy of the ADS1118's temperature sensor typically is 0.2°C, with a minimum and maximum of ±0.5°C. Careful layout techniques allow you to keep the entire ADS1118, J_2, and J_3 at the same temperature on the isothermal block.

To find the temperature at site A, measure and then convert the temperature of the isothermal block to its equivalent EMF voltage by performing a reverse look-up on the table of the J-type thermocouple. Then add the equivalent EMF isothermal voltage and the J_1 EMF measured voltage. Finally, convert the total voltage to temperature with the J-type thermocouple's look-up table.

The price of thermocouples may vary, depending on the accuracy rating, the purity of metals, the integrity of the weld bead, and the quality of the wire insulation. Regardless, thermocouples are less expensive than other varieties of temperature sensors. Thermocouples have their advantages when you use them in harsh, high-temperature applications. They are rugged and impervious to hostile environments.

Read parts one, two, and three of this series at http://bit.ly/rpSnOp, http://bit.ly/s6Llbu, and http://bit.ly/u4zJs7, respectively. EDN

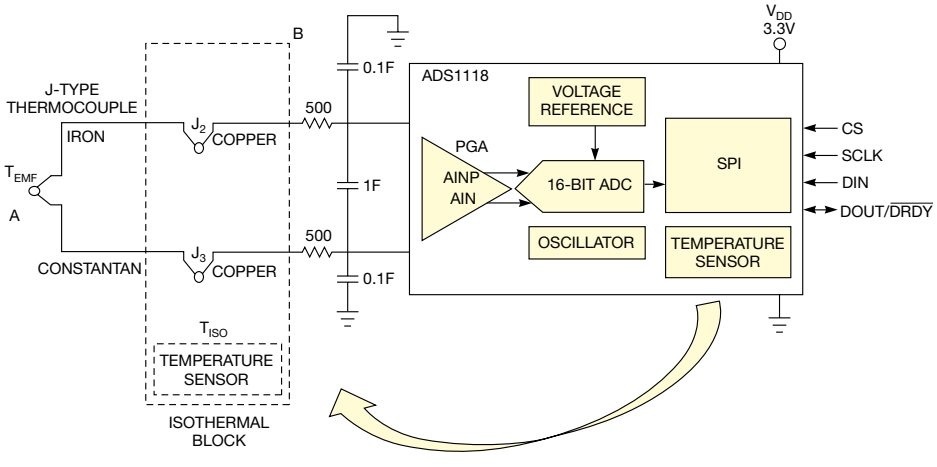

Figure 1 This single-supply thermocouple application uses a J-type thermocouple.

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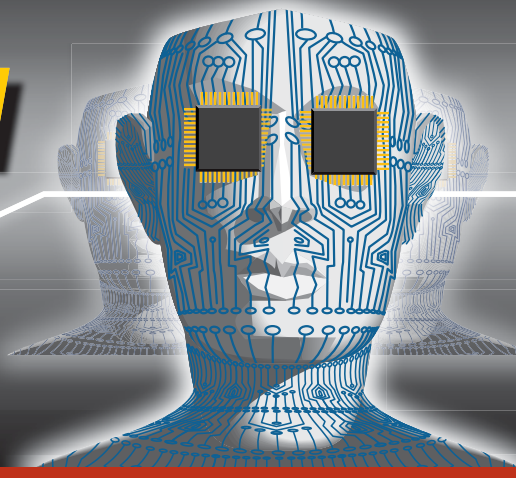

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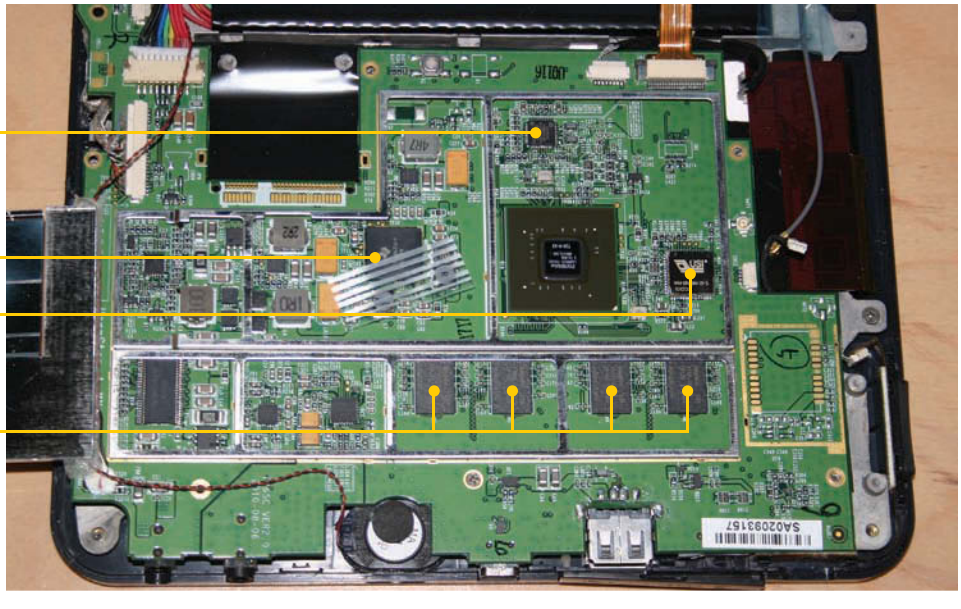
Unleashing the power of Tegra-2

The less-than-$300, Android 2.2-based ViewSonic gTablet has the horsepower to make it competitive with high-end devices—that is, if you have the stomach and time for rooting and hacking. The device uses a 1-GHz Nvidia Tegra-2 dual-core ARM A9 processor and has a 10.1-in. display with 1025×600-pixel resolution. It's got all the bells and whistles needed for video, audio, and wireless connectivity, with 802.11b/g/n Wi-Fi and Bluetooth, but no GPS, a 1.3M-pixel, front-facing camera, and a 3650-mAhr lithium-ion battery. However, out of the box, the gTablet is sluggish and a bit clunky and awkward.

Whichever way you go, the cost makes it a decent deal for the holidays, but with lots of competition, such as the Vizio VTAB1008. The Amazon Kindle Fire is sucking up all the oxygen, and its hype might suffocate the gTablet and the Vizio. From what I'm seeing, though, I'm not eager to buy into the Amazon ecosystem.

Part of the device's clunkiness may be due to the installed Tap 'n Tap user interface, and part is due to the general form factor. It's too big to be pocket-portable and too small to be a real high-end display. However, it has a low-cost screamer of a processor, and that feature, combined with less-than-stellar security, has led to a subculture of rooters and hackers who can turn the gTablet into a powerful portable multimedia system.

Rooting a tablet voids the warranty, of course; if you have problems, you're on your own. As one attendee at the recent ARM TechCon pointed out, rooting the device is a case of caveat emptor, but, if you're the rooting type, that caveat presents even more of a challenge to do it. I didn't get around to doing so before my teardown. For more on rooting, read "New Guide for Rooting the ViewSonic gTablet," by Ray Waldo, http://bit.ly/rHS18X, or "Do not root your gTablet," http://bit.ly/rMLoX8.



The ViewSonic gTablet's key components include four 4-Gbyte Hynix HY5PS1G831C FP S6 DRAM modules, a Texas Instruments' TPS658621A lithium-ion power-management controller, an SMSC USB251 USB 2.0 controller hub, and a USI WM BN Wi-Fi+Bluetooth module.

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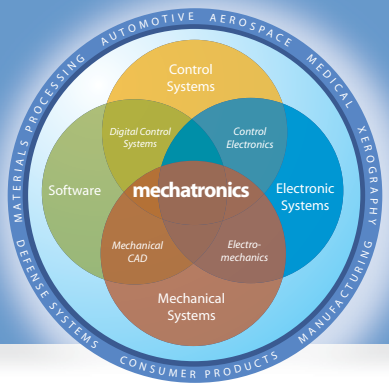

What is IT?

The technology of information enables mechatronic problem solving.

Several US and foreign universities are teaming to develop an engineering and applied-sciences campus in New York. They hope that this center will rival high-tech hubs in Boston and Silicon Valley. I was interested to learn that IT (information technology) leads the city's list of the center's disciplines. I shouldn't have been surprised; over the past decade, many colleges have been created with the term "IT" in their names. But what is IT, and why is it growing in importance? What is its relationship to engineering and to mechatronics? Depending on whom you ask, you will get a variety of answers.

To get a better understanding of this misunderstood field, I turned to a colleague with a unique perspective. George Corliss, a professor of electrical and computer engineering at Marquette University, has more than 40 years of experience in mathematics, computer science, and computer engineering. He and I always try to find ways to be inclusive, so our conversation took that tack. He started our discussion by turning around the subject to focus on the technology of information; that reframing was eye-opening and led to valuable observations.

If IT is separate from any discipline's problem-solving process, the result is a system without focused, timely information, which may be undesirable, unfeasible, unsustainable, or unusable.

Human beings are inherently problem solvers, and all disciplines, including business, social science, science, and engineering, need critically thinking problem solvers. Problem solving requires complete, accurate information at the right time and in the right context. This requirement becomes more of an imperative when people are solving complex problems because, to avoid catastrophe, you must manage complexity. The technology of information deals with acquiring, transmitting, storing, analyzing, disseminating, and applying information in human-centered problem-solving activities. Humans must transform that information into useful knowledge for the problem at hand. That connection between all problem-solving disciplines and IT is critical.

In mechatronics and engineering, systems have the power domain of sensors, actuators, and mechanical systems and the information domain of computer control and human interfacing. IT represents much more than those domains, however, and success in human-centered design depends on it.

Kevin C Craig, PhD, is the Robert C Greenheck chairman in engineering design and a professor of mechanical engineering at Marquette University's College of Engineering. For more mechatronic news, visit mechatronics zone.com.

An analogy that applies in this case is the field of controls. This area is a pervasive, enabling technology that people for many years thought of as the domain of specialists and applied it as an afterthought, even though it was essential. We now well appreciate that integrating controls into a system design from the start of the design process leads to a superior design in which all trade-offs are available. The challenge is not in realizing that something must happen but in making it happen.

You could say the same thing for IT. If IT, as a discipline, is separate from any discipline's problem-solving process, the result is a system without focused, timely information, which may be undesirable, unfeasible, unsustainable, or unusable. Simply put, it might be the wrong solution to the problem.

Is this scenario now happening? If so, how can we change it? If not, how can we prevent it from happening? It is all about culture and perception. IT practitioners are tool builders and integrators, not servants to set up and maintain computer systems and install software. They focus on the fundamentals of human-computer interaction, information management, programming, networking, and Web systems; information assurance and security; system administration and maintenance; and system integration and architecture. They must identify and analyze user needs and take them into account in the selection, creation, evaluation, and administration of computer-based systems. They must also be able to effectively integrate IT approaches into the user's environment. Interaction is a two-way street, and we must all embrace this concept for the competitive advantage for which we all strive. EDN

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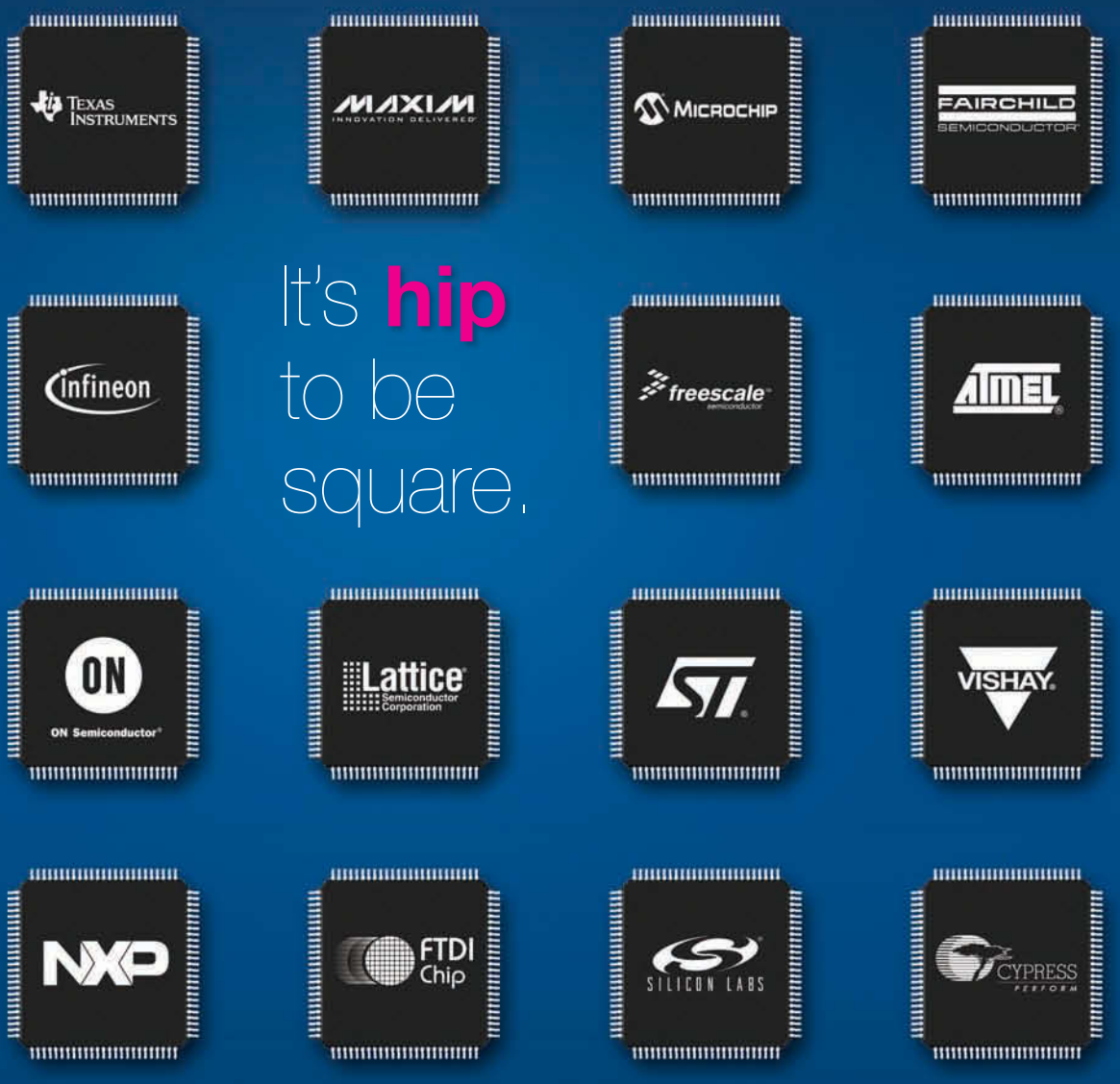

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LOOKING AHEAD TO 2012 OGIES

The last 12 months will be remembered for many reasons—from economic turmoil and political uprisings to natural disasters and the death of Osama bin Laden. From a technologist's point of view, however, two things stand out: the closing of the Space Shuttle program and the passing of Steve Jobs. Both were catalysts for innovation and change that will ripple for years to come, proof positive that no matter what goes on across the geopolitical landscape, engineers—the creators of technology—never rest. In this article, we pay homage to those creators with a look at some of the hot trends and technologies in 2011—and a look ahead to 2012—that engineers have helped create and advance.

IMAGE(S): THINKSTOCK

THE SCIENCE-FICTION FUTURE OF MEDICAL IMPLANTS IS HERE

Steve Taranovich,
Contributing Technical Editor

With iPhone, iPad, and BlackBerry circuit miniaturization and integration, lower-power processes plus cost savings, semiconductors are now finding their way into medical implants, making the seemingly impossible realizable in the human body. Implantable innovations from such companies as Cactus Semiconductor Inc for neurostimulation, pacing, defibrillation, ultrasound, and medical monitoring will revolutionize the medical-implant market. The company's alliance with Freescale Semiconductor to develop SOC products for the medical market promises to accelerate the development of innovative new implants.

Plessey Semiconductors recently announced the availability of commercial samples of its EPIC (electric-potential integrated circuit), which can detect changes in electric field through clothing and even through walls (**Reference 1**). The first products are optimized for use as a noncontact ECG (electrocardiogram) sensor and provide resolution as good as or better than conventional electrodes. Can brain activity and other electrical signals, such as spinal-cord activity, be far behind (**Figure 1**)?

Medtronic is developing the ability to sense, process, and telemeter signals from the nervous system (**Reference 2**). This development could lead to improved monitoring of disease progression and better therapy in applications as diverse as movement disorders, epilepsy, and psychiatric conditions.

As understanding of neural dynamics improves, embedded sensors and chronic signal classification might also help optimize and deliver therapy in real time—that is, in a closed-loop mode. The NI (neural-interface) technology required for deriving brain-state information directly from neural signals resides in a BMI (brain-machine interface)—a system that senses and decodes a subject's intentions, usually in the context of motor control. Bidirectional BMI provides feedback to the nervous system, such as stimulation of nerves to provide bidirectional information flow in the nervous system.

Figure 2 shows an implantable system using medical-device technology that the government has approved for human use. (The modified device prototype used in this research study was based on a commercially approved Medtronic device—Activa PC. This modified device and its features have not been approved by the FDA for human use.) The right side of the **figure** shows a close-up of the side of the hybrid board containing the sensing and algorithm electronics. The other side of the hybrid (not shown) contains the stimulator and telemetry electronics. This work currently is in preclinical research. There are several animal, not human, studies investigating disease. And there are no approved products yet.

Research at the Georgia Institute of Technology has shown that nanogenerators can convert nanoscale mechanical energy into electrical energy with piezoelectric nanowire arrays (**Reference 3**). These power sources are critical for sustainable, maintenance-free, and continuous operation of implantable biosensors. Self-powered implants can eliminate battery needs so that the medical implant can operate as a type of "living species." A nanosystem in the near future will integrate multifunctional nanodevices that will surround this living species.

Andy Hoffer, MD, and colleagues at Lungpacer Medical Inc are developing a far less medically invasive technique to electrically pace the phrenic nerves to maintain diaphragm strength and resistance to fatigue that will slowly wean patients off mechanical ventilators using only local anesthesia (**Reference 4**).

AT A GLANCE

- Handheld commercial products now include semiconductors that are making their way into medical implants.
- Mobile apps show great promise as the next wave of measurement instruments, reference tools, computational tools, simulators, and system controllers.
- Next year will mark the beginning of the integration of smart buildings into the smart grid, with power, air conditioning, and even lighting under automatic control.
- The diversity of LED drivers is starting to resemble that of their analog cousins: op amps and ADCs.
- In 2012, low-power and ultra-low-power wireless devices will continue to improve our quality of experience in life.
- New programmable-logic chips are bigger than before in capacity and performance. Components are smaller in capacity and packaging.
- Automotive-electronics technology will make the self-driving car a reality.
- Manufacturers are improving handheld devices' audio performance on several fronts, including the devices' built-in hardware- and software-processing capabilities and the quality of the media.
- The balance between traditional microcontroller technologies and new kid on the block ARM is providing an area of interest.
- In PCB design, exotic substrates and fabrication methods are now commonplace.

MOBILE APPS: THE NEXT ENGINEERING TOOL

Martin Rowe, *Senior Technical Editor, Test & Measurement World*

When desktop computers first arrived some 30 years ago, engineers quickly used them to solve engineering problems. Engineers also developed many I/O boards for the ISA (industry-standard-architecture) bus, and later the PCI bus, with I/O such as digitizers and DSPs. Laptops then enabled portable engineering hardware and software, so engineers developed and used peripherals, first using the parallel port and then the USB port. Today, you can find oscilloscopes, meters, logic analyzers, and development tools with USB ports.

Now that we have tablet computers and smartphones, engineers have again turned these computing platforms into engineering tools. Though still in their infancy, mobile apps show great promise as the next wave of measurement instruments, reference tools, computational tools, simulators, and system controllers.

The Embedded Systems Conference, which took place in Boston in September 2011, included a demonstration of an oscilloscope module that

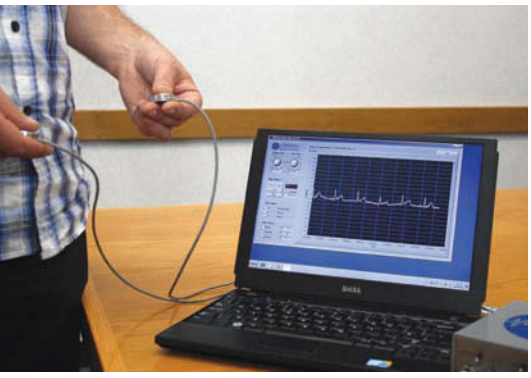

Figure 1 Analysis of heart functions using ECG is critical for correct diagnoses. Plessey's first EPIC sensor product, which can detect changes in electric field through clothing and even walls, works well in noncontact ECG applications.

attaches to an iPad, an iPod Touch, and an iPhone. The Oscium oscilloscope is a basic instrument with one analog channel and four digital channels (**Figure 3**).

What makes the iPad so intriguing as a measuring instrument is its user interface. When you want to zoom in, you simply use your fingers, just as you do with any other application. You don't need knobs—or even virtual knobs—to quickly expand the waveform (**Reference 5**).

Other measurement apps have also appeared on the market. Redfish Instruments has developed a wireless digital multimeter that comprises a hardware unit that you control using an iPad or an iPhone, which provides the user interface that simulates a handheld meter that lets you turn the function "knob" to select a measurement (**Figure 4**).

Small companies aren't the only ones getting into mobile apps. Agilent has developed a mobile-device app for the iPad and Android devices that controls some LXI (LAN-extensions-for-instrumentation)-based test equipment. You can download a development tool for developing your own iPhone or iPad app, as well as examples of control apps for the 34972A data-acquisition logger (**Reference 6**).

National Instruments has a network of third-party developers for its LabView graphical programming language, and one developer has created an iPhone/iPad app for data monitoring through a Web server (**Reference 7**). You can download the LabView and iPad code at the same Web site.

There's more to the iPad and the iPhone than measurements. You can find circuit-design tools, such as circuit simulators, resistor color-code references, and many scientific calculators. Some are free; others cost a few dollars. Copley's free Resistor Codes tool lets you roll through colors as it displays resistor values and tolerances. Kruger Systems' $9.99 iCircuit simulates analog and digital circuits with components such as resistors, capacitors, MOSFETs, switches, logic gates, displays, and flip-flops. Laura Villani's DCircuit Lab helps you design logic circuits, and her $5.99 Bode & Nyquist app plots graphs of circuit-transfer functions. The free Electrical Toolkit calculates component values of passive lowpass RC (resistance/capacitance) filters and RLC (resistance/inductance/capacitance) circuits. It also has a resistor color-code "roller" that you use to enter colors with text, and it calculates resistor values.

Scientific calculators for your iPad or iPhone are available from many developers. For example, the free PocketCAS comes with a host of functions that you can use in formulas to get numerical results. Combine those functions with defined variables and get plots. PocketCAS has a few constants that you can use in your formulas. These applications are but a few of the many available at the App Store.

ENERGY CONSERVATION SPURS LED-LIGHTING ACCEPTANCE

Margery Conner, *Technical Editor*

Next year will mark the phasing out of inefficient lighting sources in the United States, as specified in the Energy Independence and Security Act of 2007. Although the act does not specifically ban incandescent lights, their technology cannot meet the new lighting-efficacy specifications that the bill lays out.

Just in time, affordable LED-based replacement lights are becoming available. Philips' 60W dimmable LED bulb (**Figure 5**), winner of the DOE's (Department of Energy's) $10 million L-Prize in 2011, will sell for $22 when it debuts next month; then, as a condition of the L-Prize, the price will decrease to $15 in 2013 and then $8 in 2014.

CFLs (compact fluorescent lamps), however, which government or utility companies frequently subsidize, usually have a lower purchase price. The power outages and rationing in the aftermath of the tragic March 2011 Fukushima

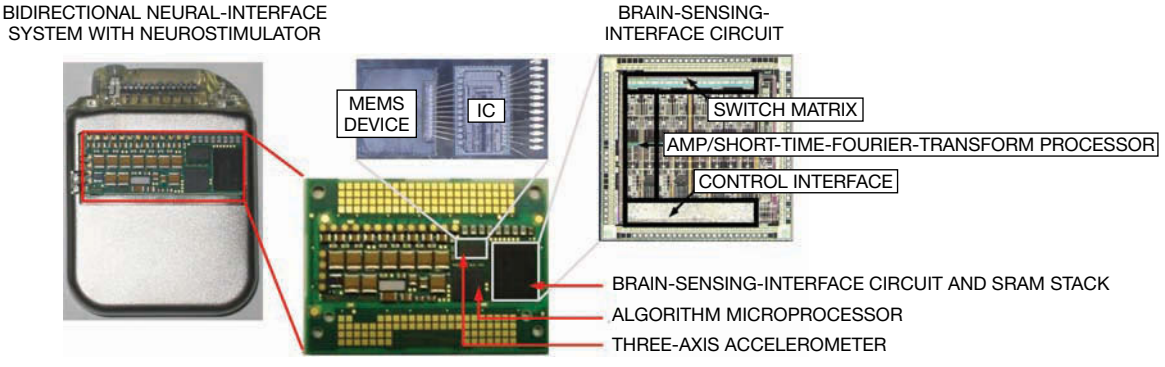

Figure 2 This prototype of an implantable bidirectional BMI may soon stop body tremors or prevent seizures (courtesy Medtronic Inc).

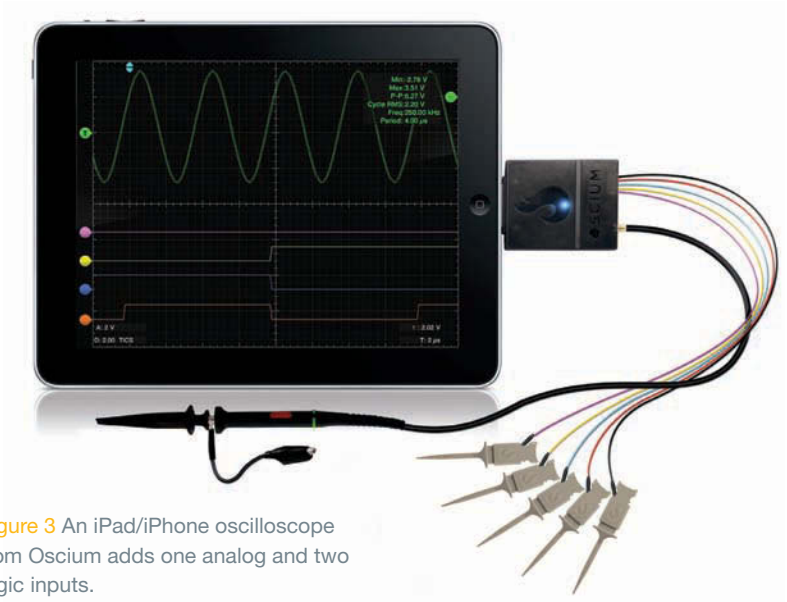

Figure 3 An iPad/iPhone oscilloscope from Oscium adds one analog and two logic inputs.

earthquake are having an effect in this area: Japan, usually an early adopter of technology to begin with, is purchasing LED bulbs at a higher rate than analysts expected. Months after the earthquake, the continued rationing of power to the nation resulted in a more rapid adoption of energy-efficient LED lighting by both businesses and consumers, accelerating the acceptance of the initially more expensive LED lamps and luminaires.

Another consequence of the Fukushima earthquake that goes far beyond Japan's borders is the shift in global sentiment regarding the safety of nuclear-power plants. Germany announced that it would discontinue plans to build more nuclear plants. Although Germany has made a big push in recent years to incorporate solar power into its energy-sources mix, solar is far from able to replace the anticipated output of the planned nuclear plants. Instead, coal will be the source of the new plants. Both Germany and France considered coal to be "fuel non grata" before the earthquake in Fukushima occurred.

Emerging economies, such as China and India, continue to build coal-fired power plants. Toward the end of 2011, the DOE calculated that the global output of carbon dioxide jumped by the biggest amount on record, a sign of a global economic recovery and a lack of success on the part of global efforts to reduce the amount of greenhouse gases. A possible ray of hope is the success of hydraulic fracturing of shale to relatively cheaply produce natural gas. Natural gas, although a greenhouse-gas generator, is much less so than coal, according to its supporters. Others, however, suggest that fracking pollutes nearby groundwater.

This year also saw utilities continue to move toward a smart grid in the United States, with smart meters becoming common in many communities. However, many utilities did not explain the technology behind smart meters or why they are an important part of modernizing the aging US power grid. Sure enough, some consumers greeted the smart-meter rollout with fear and loathing: The transmission of energy-usage information through wireless communication spurred fears of health problems from electromagnetic fields, as well as fears that Big Brother would have access to customers' power-usage information—a possible invasion of privacy.

In response, utilities increased their educational efforts, consumer response improved, and the furor appears to have abated. With smart meters becoming widespread, 2012 will mark the beginning of the integration of smart buildings into the smart grid, with power, air conditioning, and even lighting under automatic control. Look for smart buildings to become commonplace in commercial and industrial settings long before they gain acceptance in private residences, though. Large buildings with predictable usage profiles and high electricity costs will yield a faster payback, making a compelling case for facilities managers.

LED DRIVERS ARE MAKING THAT GLOW HAPPEN

Bill Schweber, *Editor, EE Times' Planet Analog and Power Management Designline*

LEDs are showing up everywhere. Over the past decades, they have migrated from merely being solid-state replacements for basic incandescent- and neon-bulb indicators to finding use in backlighting, large-scale signage, and even area illumination. And why not? They have many advantages in their efficiency, lifetime, and form factor, as well as other attributes. But the less-recognized hero—and sometimes critical factor—of LED installations is the LED's driver, which efficiently delivers ac- or dc-rails voltage as a properly managed current to the LED. As LED opportunities become more widespread and technically diverse, the drivers have to deliver.

This year, new LED-driver makers have carefully focused on the needs of low-, midrange-, and high-power applications at low to high voltages and for individual and group LEDs. In other words, we have met the market, and its name is diversity. For example, streetlighting is a non-glamorous but attractive opportunity. Unlike the LED, which is a current-driven, low-voltage-drop component, however, streetlamps operate from a minimum of 120V ac, and many have power lines that operate as high

Figure 4 A wireless digital multimeter from Redfish Instruments lets you remotely view and log measurements over a Wi-Fi network.

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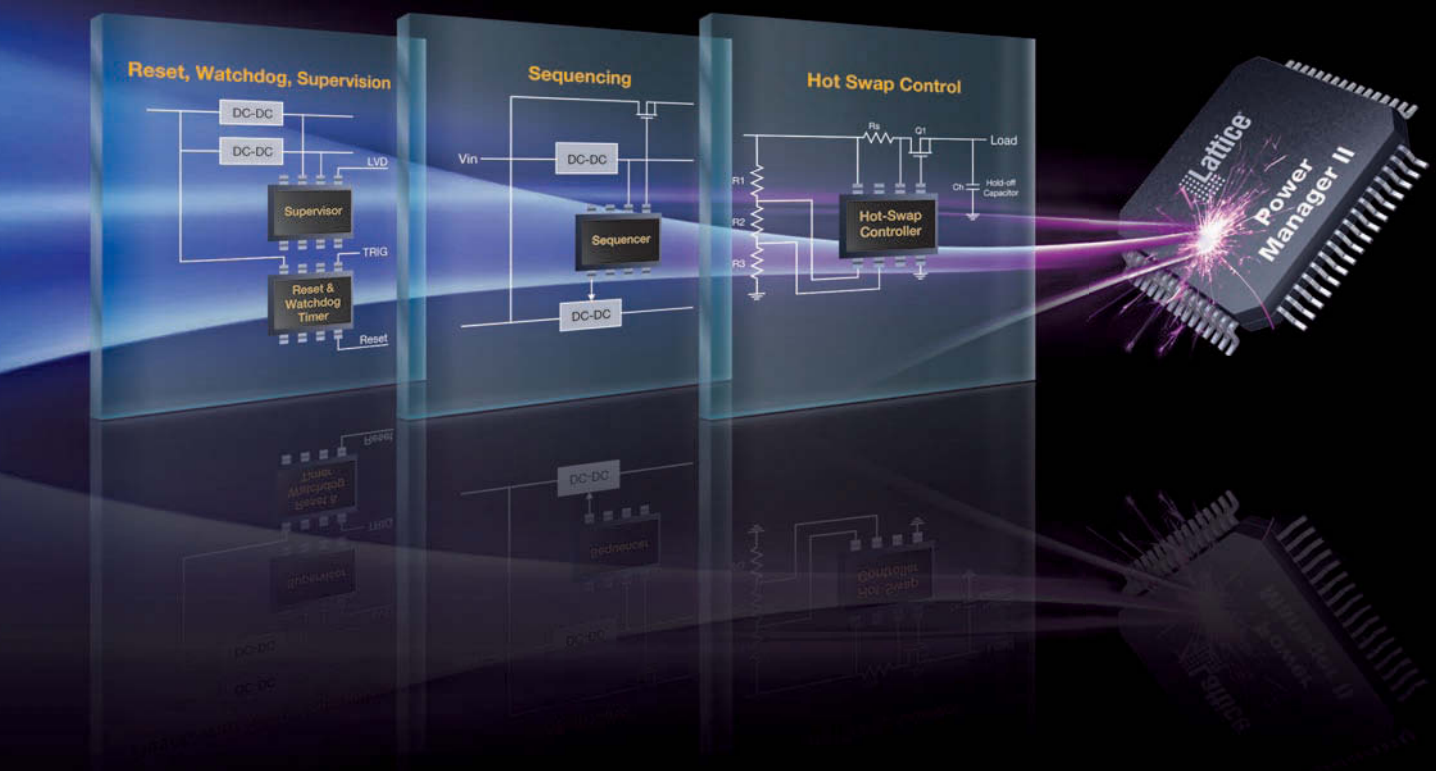

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Figure 5 This Philips LED-based dimmable 60W replacement bulb won the US Department of Energy's $10 million L-Prize. Bulbs should be in stores early next year.

as 480V ac. Any power supply usually needs line-to-load isolation for user safety. To support this specialized situation, several vendors have announced LED drivers, which have the requisite hooks, as well as other fault-tolerant and safety-centric features.

Wide-area and room lighting is another hot application, but it, too, has its unavoidable constraints. The physical construction of the light fixture, or luminaire, is often at odds with the thermal demands of the LED die, which gets extremely hot despite its luminous efficiency. Unlike the incandescent bulb, which radiates its waste heat, the LED keeps it in the die area. This lighting application also often needs dimming, which manufacturers now usually implement with a TRIAC-based circuit, which implements a version of PWM.

Dimming and LEDs present a different challenge. The simple way to dim is to cut back on the current, but that approach brings unsatisfactory LED illumination in color consistency, linearity, and dynamic range. Further, LED drivers do not mesh well with the huge installed base of TRIAC dimmers. So LED-driver vendors are addressing dual opportunities: ICs that provide LED-compatible dimming using constant-current drive levels with PWM control for new installations, on the one hand, and TRIAC-friendly drivers for the dimming units in place, on the other.

Single-unit LED installations are not the only parts of LED-based systems that have specialized requirements. Strings and arrays of LEDs for backlighting and large-area screens and signage require drivers that can support series, parallel, or combined series/parallel configurations. For large arrays, these drivers must also implement various types of LED control, multiplexing, and addressing.

What does it all portend for 2012? More vendors are entering the market because they see the huge growth and opportunities—and maybe even the possibility of proclaiming their contribution to the "green" message. Vendors are also assessing how they can bring their expertise in high-dc/dc-converter efficiency, low quiescent current, or high-voltage design and process to drivers. More second and alternative sourcing of basic driver ICs is becoming available, and the fragmentation of drivers' offerings is increasing as they target unique application niches. The diversity and application-optimization of LED drivers are starting to resemble their analog cousins: op amps and ADCs.

ULTRA-LOW-POWER WIRELESS MAKES INROADS INTO MANY APPLICATIONS

Janine Love, *Editor, EE Times' RF/Microwave Designline*

We hear these things all the time: Our population is aging, and we need more medical-care alternatives. Social networking is thriving, and people want creative new ways to communicate with their friends. Home automation and security represents a market ripe for new innovations. People want to exercise more but need more motivation to do so.

Enter low-power and ultra-low-power wireless. Once the insignificant stepchildren of the wireless world, lower-power wireless technologies are hot, and they are making inroads into all of these applications. With the new iPhone 4S sporting a Bluetooth Version 4.0 chip, which can communicate with Bluetooth low-energy chips, you can bet that the general public will soon start to take notice.

The new wireless technologies come in two flavors: low-power wireless, such as ZigBee and Bluetooth Version 4.0, and ultra-low-power wireless, such as Bluetooth Smart, ANT, and products from companies including Nordic Semiconductor. The major difference is that low-power wireless has an average power consumption in milliamps, whereas the average power consumption of ultra-low-power wireless is measured in microamps, allowing it to run from coin-cell batteries. Low-power wireless is already fairly well-established, targeting applications such as smart metering. The interesting activity for 2012 will be in ultra-low-power technologies.

ANT Wireless, whose proprietary ultra-low-power wireless technology, ANT+, has made it the market leader in sports and fitness equipment, now has

Figure 6 Nordic's ultra-low-power RF products enable designers to build wireless connectivity into everything from gaming headsets from Emotiv (a) to tooth polishers from Discus Dental (b).

its technology in smartphones. ANT has shipped approximately 16 million devices to date, and the market for ANT ICs in sports, fitness, and health sensors should triple between 2010 and 2015, according to IMS Research, despite the entry into the market of low-energy Bluetooth. Available products include monitors for blood glucose, physical activity, and blood pressure.

The Bluetooth SIG (Special Interest Group) keeps its eye firmly fixed on the prizes in the market. Bluetooth Version 4.0 includes a specification for low energy, and it is positioning itself to take the ultra-low-power wireless market by storm. After a series of monikers, Bluetooth Smart has now become the name of choice for these devices. Bluetooth Smart is still lagging behind more established low-power technologies, such as ANT, in profiles that you can use to build actual devices. The Bluetooth-design ecosystem is huge, however, and this giant is on the move. Early products will include health and medical devices and 3-D-TV glasses. Look for many more innovations to emerge from this technology.

Nordic Semiconductor is by all rights a pioneer in ultra-low-power wireless, offering chips for ANT, Bluetooth low energy, and its own proprietary 2.4-GHz and less-than-1-GHz RF products that can operate from coin-cell batteries (**Figure 6**). Nordic has manufactured several generations of its ultra-low-power chips and appears to be strengthening its specialized stronghold in the market. Texas Instruments, which provides network-processor chips for low-power links, has also recently released radio chips for ANT and Bluetooth low energy.

A group at Dialog Semiconductor is working to deploy DECT (digital-enhanced-cordless telecommunications) in the low-power-system market. DECT, an old standard that originally targeted use in business phones, has its own dedicated spectrum and, hence, low interference. It supports star-, mesh-, and tree-network configurations, and it can integrate voice and data functions on the same hardware. To create the low-power version of DECT, engineers simply added fast switching to the devices, making possible a deep-sleep mode. This technology has a lot of potential, and it will be exciting to see where it goes.

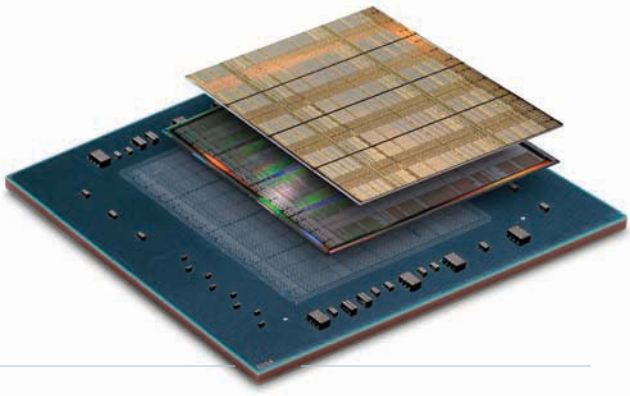

Figure 7 Xilinx's Virtex-7 2000T is the highest-capacity programmable-logic device, containing 6.8 billion transistors. It includes (from top to bottom) four FPGA dice, a silicon interposer, and the packaging substrate.

In the meantime, we can expect 2012 to be the year when low-power and ultra-low-power wireless devices continue to improve the quality of experience in life, by giving us peace of mind, convenience, and new forms of entertainment.

THE HOTTEST TRENDS IN PROGRAMMABLE LOGIC

Clive "Max" Maxfield, *Editor, EE Times' Programmable Logic Designline*

So many incredible developments and amazing product announcements have happened this year that the best we can do is to briefly skim through some of the more notable items. Among them, Altera early this year announced its forthcoming portfolio of 28-nm FPGAs, which the company will offer in the form of the Cyclone V, Arria V, and Stratix V families. These highly differentiated families target specific market segments. The differentiations include the process itself. One family uses a low-power process; another, a high-performance process. The devices also have different transceivers, DSP cores, memory-block sizes, and so forth.

The folks at Lattice Semiconductor are also working on interesting products. In March, the company announced its mixed-signal programmable Platform Manager devices—single chips that integrate a variety of power- and digital-management functions. A month later, Lattice announced volume shipments of its 65-nm, flash-memory-based MachXO2 PLD (programmable-logic-device) family. The MachXO2 provides designers a do-it-all PLD for high-volume, cost-sensitive designs.

Silego's current claim to fame is its GreenPAK device families, which are small mixed-signal FPGAs that you can design and program in just a few minutes and that cost only a few cents. In September 2011, Silego announced the GreenPAK 2 devices. With only 12 pins in a 2.5×2.5-mm package, these tiny chips can perform the functions of a bunch of other simple analog and digital parts on the board, thereby saving cost, power, and board real estate. In a typical usage scenario, a GreenPAK chip will replace 10 to 15 regular components, but one of Silego's customers managed to replace 36 components, which is significant whichever way you look at it.

The folks at SiliconBlue Technologies are specialists in creating custom mobile-device products for handheld applications. In July 2011, the company announced the availability, including fully functioning samples, of the new iCE40 Los Angeles mobile-FPGA family. Fabricated on Taiwan Semiconductor Manufacturing Co's 40-nm, low-power standard CMOS process, the LP (low-power) series and the HX (high-speed) series target devices such as smartphones and tablets, respectively.

As usual, Xilinx has announced so many things that it's difficult to choose among them. We are all eagerly awaiting the release of the company's Zynq-7000 extensible processing platform, but the really hot news was the announcement of the first shipments of the Virtex-7 2000T FPGA (**Figure 7**). This component is the first to use Xilinx's stacked-silicon-interconnect technology, or 2.5-D ICs. The result is the highest-capacity PLD, containing 6.8 billion transistors. This product provides 2 million logic cells—equivalent to 20 million ASIC gates—which makes these devices ideal for system integration, ASIC replacement, and

ASIC prototyping and emulation.

And what's in store for 2012? The way things are leaping around in all directions at the moment, I would be loath to offer any predictions except to say "expect the unexpected."

AUTOMOTIVE ELECTRONICS: WHAT'S HOT IN 2012

Rick DeMeis, *Editor, EE Times' Automotive Designline*

In automotive electronics, 2012 looks to be a year of consolidation as technologies become more widespread across model lines. Voice recognition is touting new features and interfaces, and vendors see it as a way to distinguish one brand from another. Meanwhile, more models will feature electrified power trains. Manufacturers traditionally implement new features, such as lane-departure warning and adaptive cruise control, on high-end models. Buyers are usually more willing and have the financial means to pay a premium for these vehicles. A notable exception is Ford's 2007 introduction of its Sync system to connect consumer electronics in its low-cost models. Young buyers, who embrace technology that connects them to their friends and music, can afford these models in first-time new-car purchases, for example.

Nearly 80% of buyers request Sync in those vehicles in which it is available. Ford and partner Nuance Communications used an alias-rich grammar in the system software to make Sync's voice-commanded functions easy to access with minimal training. According to David Champion, auto-test director at *Consumer Reports*, the organization's main focus is safety, and Sync reduces driver distraction by using simple voice control for complex tasks, including iPod menus and an abundance of hard keys for functions such as radio presets, tuning, and climate control. However, the next-generation MyFord Touch interface received less than sterling reviews because the center stack includes only a touchscreen for nonvoice user inputs. The automaker is revising the system for more tactile feedback inputs. According to Ford, future software upgrades should improve response speed, graphics, stability, and ease of use.

Electrified power trains will appear in more models. Ford, Mitsubishi, and Honda plan in 2012 to introduce all-electric or hybrid vehicles (**Reference 8**). Honda plans to roll out an enlarged Prius V, and Buick will launch the eAssist hybrid power train as standard on its four-cylinder base model LaCrosse. The system comprises a small, 65-lb, 0.5-kWhr lithium-ion battery pack and a 15-hp liquid-cooled motor/generator instead of an alternator (**Figure 8**). A seven-groove belt connects the motor/generator to the engine/transmission; the belt not only augments engine power but also functions as a regenerative brake and start/stop motor.

Buick based the eAssist hybrid-system electrical-management algorithms on those for the Chevy Volt (**Reference 9**), according to Al Houtman, vehicle-performance manager for front-wheel-drive hybrid programs at GM, Chevrolet's owner. Operation uses the motor/generator for torque smoothing and to allow the internal combustion engine to run at its most efficient point and to maintain the battery's state of charge.

Next year, ESC (electronic stability control) will be mandatory on all cars and light trucks in the United States. ESC is probably the most significant safety feature since the government mandated implementation of three-point seat belts; *Consumer Reports*' Champion says that he would not let a teenage driver drive a car without ESC.

Automotive-electronics technology will make the self-driving car a reality. The public is already seeing such systems in adaptive cruise control and automatic braking. An autonomous vehicle should find wide acceptance among the numerous baby boomers now reaching retirement age because it will allow them to retain the freedom and independence they cherish by giving them mobility as their driving skills decline. This technology can reduce the tendency for seniors to move to retirement or assisted-living facilities, reducing health-care costs, as well.

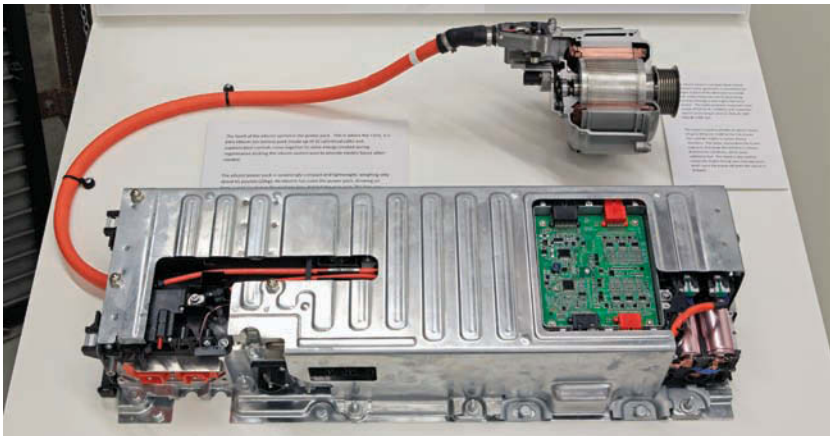

Figure 8 Buick's eAssist comprises a 0.5-kWhr, 32-cell battery pack, control electronics, and a 15-hp motor/generator to augment the four-cylinder engine on a Buick LaCrosse, making it a light hybrid. This display of components shows a shorter cable to save space. In the vehicle, it runs from the battery over the rear axle to the motor/generator mounted on the engine.

AUDIO PERFORMANCE ADVANCES IN PORTABLES

Rich Pell, *Editor, EE Times' Audio Designline*

The ongoing convergence of entertainment and computing products is increasing consumers' expectations of audio and video performance on devices such as smartphones and tablets. To a large extent, video quality is keeping up; despite their small screens, these devices offer impressive video and graphics capabilities. Their audio performance, especially from the devices' built-in transducers, is another story—a result of the significant size limitations that the devices' small and thin form factors impose.

Manufacturers are addressing these concerns on several fronts, including the devices' built-in hardware and software/processing capabilities, as well as the quality of the media itself—whether it's streamed from the Internet or a local server, or stored on

the device. Dolby, Fraunhofer IIS, and other companies, for example, offer codec solutions designed to improve sound from online streamed audio services while still minimizing bandwidth requirements.

With ever-increasing storage-space availability, the size—and therefore quality—of onboard stored media, such as music files, is now less of an issue than ever. Some audiophiles lament the quality of popular lossy compressed file formats, such as MP3, which is inherently technically inferior to CD-quality or higher formats. This complaint ignores the fact that encoding and decoding techniques have improved significantly since the first recordings appeared in that format more than 10 years ago. In fact, codecs, such as the open-source LAME encoder, are now so good that well-encoded 192-kbps MP3 files have been shown to be virtually indistinguishable from CD quality in blind listening tests.

Increasing storage capabilities and Internet bandwidth are making it easier than ever to create, store, and distribute high-quality audio content. Those audiophiles who need more than Amazon's and iTunes' 256-kbps compressed file downloads can purchase CDs, rip them using FLAC (free lossless audio codec), and stream CD-quality audio to their device using apps such as iPeng for iOS or SqueezePlayer for Android.

However, even with the highest-quality-audio source material, you can expect only so much from the tiny speakers and microphones in today's portable electronics. But manufacturers are constantly improving them, along with the associated amplification and conversion electronics. One recent example is STMicroelectronics' MP34DT01 MEMS audio-sensor omnidirectional stereo digital microphone, which allows designers to place the microphone membrane closer to the acoustic port on top of the package to increase performance without any penalty in size.

Fairchild Semiconductor recently announced a mobile-audio initiative to address the challenge of improving audio performance in mobile devices and followed up that announcement with the introduction of the FAB1200 Class G headphone amplifier and FAB2200 audio subsystem. Other devices, too, such as Wolfson Microelectronics' WM8918 ultra-low-power audio DAC and Maxim Integrated Products' MAX98089 stereo-audio codec, are designed to improve audio performance in portable systems.

Ultimately, however, the most promise may lie with software-based techniques to correct and enhance the sound quality in portable systems. These techniques include equalization, automatic gain control, dynamic-range compression, sophisticated psychoacoustics, and custom audio algorithms. Wolfson Microelectronics' programmable stand-alone WM0010 audio DSP, for example, offers off-the-shelf algorithms and allows a manufacturer to integrate its own technology. The company's WM5100 audio SOC integrates three custom DSP cores, allowing manufacturers to use their own or licensed algorithms.

Texas Instruments' LM48901 configurable spatial processor aims at addressing audio-sound-stage limitations in multispeaker portable systems, including tablets (**Figure 9**). The device, along with its companion software, allows designers to easily design spatial audio enhancement for applications with up to 16 loudspeakers to create an immersive listener experience.

Figure 9 Texas Instruments' LM48901 configurable spatial processor and similar products improve the sound from small and closely spaced speakers on portable electronics. The processor uses loudspeaker-array technology to produce an immersive end-user audio experience.

MICROCONTROLLERS: HIGH-END DEVICES FLOURISH

Colin Holland,
Editor, EE Times' MCU Designline

It is easy to regard the recent history of microcontrollers as BC and AC—before and after Cortex! Less than seven years ago, the ARM technology turned its focus directly on the microcontroller sector, and Luminary Micro was formed, becoming the first licensee. The Cortex-M now has 123 licensees; five new companies signed up in the last quarter, and nine customers extended their deals. ARM this year estimated that its royalty opportunity for 2015 was 19 billion units a year. Last year, it reported that 500 million devices used its technology, which gave it a 10% market share.

According to market researcher Databeans, shipments of ARM-processor-based microcontrollers grew at a record pace of more than 100% during 2010, compared with an approximately 37% growth for the overall microcontroller market. Databeans attributed most of this growth to an increase in sales of Cortex-M family chips, which now compose approximately 10% of total ARM shipments.

Few of the major microcontroller suppliers are holding out. Of the top nine in Gartner Inc's sales ranking for 2010, only two are not in the ARM club. The market leader, Renesas Electronics, although owning an ARM license for SOCs, has not used the technology in its microcontrollers. No. 5 Microchip retains its independence with its 32-bit microcontrollers using the MIPS M4K Core. Freescale and Fujitsu were more recent converts to the

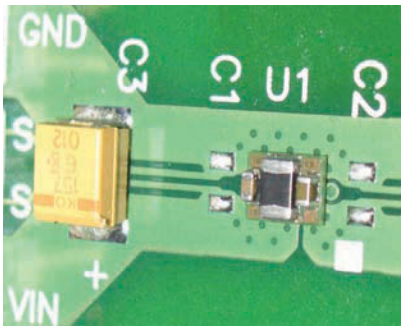

Figure 10 This TPS82671EVM evaluation board from Texas Instruments has a small PCB that integrates the power-supply-control IC, the inductor, and the capacitors, keeping valuable real estate open on the top and the bottom of the board.

adoption of Cortex for microcontrollers when they added the Kinetis and FM3, respectively.

The top nine sellers also supply 8-bit devices, 16-bit devices, or both, as well as the 32-bit parts, providing a balance between traditional technologies and the new kid on the block. The small suppliers have put many of their eggs into the 32-bit basket and are emphasizing how easy it is to switch designs to high-end technology, and long-term 4-, 8-, and 16-bit-system suppliers are saying that these designs could represent overkill for many low-end designs. Many microcontroller manufacturers offer mainly proprietary 8- and 16-bit architectures, often differentiating them through their peripheral sets, but the rate of development has slowed for low-end devices.

What is driving the interest in microcontrollers, particularly high-end devices? Electronics are proliferating in safety-critical applications, and designers need simplified system certification and development. Manufacturers are looking at the industrial, medical, automotive, military/aerospace, and solar-energy sectors. The automotive industry, for example, is under pressure to provide new and improved vehicle-safety systems, from basic airbag-deployment systems to complex advanced driver-assistance systems with accident-prediction and -avoidance capabilities.

Texas Instruments recently grouped some devices with 34 new products into the Hercules safety-microcontroller platform targeting transportation, industrial, and medical applications. The 14 dual-core, Cortex-based TMS570 and RM4x devices address random and systematic failures, with three devices now available and six ready for sampling.

Freescale has introduced a similar program, SafeAssure, which provides approaches to reduce the time to develop safety systems that comply with the upcoming ISO (International Standards Organization) 26262 and IEC (International Electrotechnical Commission) 61508 standards. The company is suggesting MPC56xx microcontrollers for automotive and PXSxx for industrial designs, including safety-shutdown systems, solar inverters, motor drives, factory automation, aerospace, and robotics.

Renesas Electronics America Inc has recently been showcasing its microcontroller-based products for portable-health-care applications, such as devices for blood-pressure, blood-glucose, and heart-rate monitoring. In these applications, organizations such as the Continua Health Alliance and ANT+ Alliance, as well as Wi-Fi, USB, and Ethernet protocols, are increasing in importance.

Many of the other suppliers are targeting the same markets, trying to get the optimum balance between the amount of on-chip memory and the peripherals, along with timely launch of tools to support designs. An accelerating trend enables design using new devices even before samples are delivered. This trend includes tools from both semiconductor manufacturers and third-party suppliers, such as IAR, Green Hills, Keil, Segger, and Lauterbach.

Early RTOS support is following a similar trend, with Micrium, Express Logic, and CMX Systems providing ports for devices as they come off the drawing board. FreeRTOS is also one of the first to move to new devices but seems to be mainly for early development rather than production designs. The low-end development boards are becoming cheaper and easier to use out of the box, and more expensive variants provide complete systems, including multiple I/Os, networking, and displays, as well as tools and other software. Microcontroller manufacturers almost always produce their own boards, but an increasing move is the trend to work with third parties with open-source prototyping platforms, such as Arduino, the PandaBoard, and Beagle Board.

PCBs: MATERIALS AND PROCESSING ARE NOW HOT TECHNOLOGIES

Paul Rako, *Technical Editor*

Engineers' traditional rationale for PCBs was to save cost over hand-soldered wiring. The earliest PCBs were made from FR (flame-retardant)-2, paper saturated with phenolic resin. Now that the telecommunications, automotive, PC, and portable electronics markets have all adopted the FR-4 board, the cost differential with paper phenolic boards is lower than it was historically. FR-4 PCBs have gone from a single layer or dual layers to eight, 12, and even 26 layers. In addition to all these layers for ground and power planes, designs routinely have 4-mil-wide lines and, with special processing, 2-mil lines and spaces.

Consumer electronics, servers, and cell-phone base stations need high layer

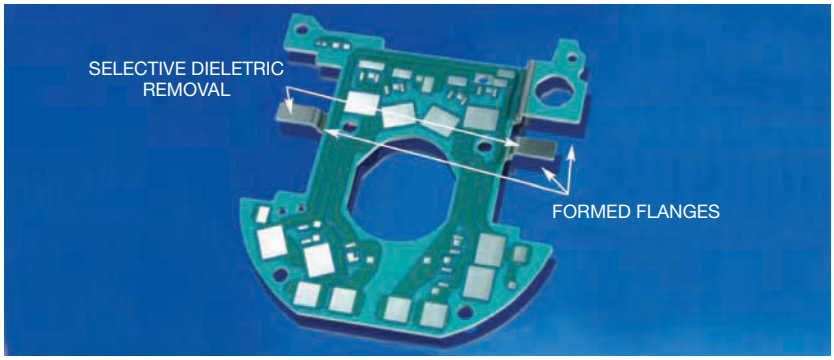

Figure 11 Metal-core PCBs can solve mechanical problems (courtesy Bergquist).

counts. Many processing options have made the PCB a truly hot technology. For example, some manufacturers are employing blind and buried vias. A via that goes down several layers but does not penetrate the whole board leaves room on other layers for more traces.

Modern vias can be small because modern processing allows for laser-drilled holes as small as 0.0025 in. In addition to small vias, PCB-fab vendors can fill vias with conductive material to remove heat or nonconductive material to keep solder from wicking down the vias and interfering with proper reflow operations. Lower voltages for FPGAs and microprocessors bring a need for greater currents. Some PCBs have 25-oz copper laminate, but they can't have 2-mil, 25-oz-copper traces. PCB-fabrication houses have different design rules.

Modern PCBs can have a dozen layers, thick copper, fine lines, and buried vias, but those specs describe just the processing side. The substrates themselves are also now high-tech. Teflon or polyamide substrates for high-speed circuits have a lower dielectric constant and are less lossy for transmitting high-frequency signals across them. Companies including Sanmina SCI, however, can now make a top-layer FR-4 substrate that is 4 or even 2 mils thick, providing a ground plane that is 4 mils away from the signal traces; thus, signal traces can be much narrower and still meet 50Ω impedance specifications. With FR-4's dielectric constant of four, a 50Ω trace is twice as wide as the distance to the ground plane. Thus, a 4-mil-thick substrate can let you use 8-mil traces to get 50Ω impedance.

Many PCB vendors can also embed decoupling capacitors and ICs in the PCB, keeping valuable real estate open on the top and the bottom of the board. Texas Instruments, for example, uses such a technology on its TPS82671EVM power-supply boards (**Figure 10**).

Metal-core PCBs dissipate heat nine times better than FR-4 PCBs. The metal core provides a solid structural mount and removes heat from the LED. The PCB's core can be copper, aluminum, or steel. You can mount and route traces to your components on a thin dielectric layer, and PCB-fab houses can form and shape the substrates to meet your needs (**Figure 11**). Vendors can provide metal cores with thickness of 30 to 125 mil. Thicker or thinner substrates are available but less common. Fab houses can also accommodate copper thickness of 1 to 10 oz. Be sure to look at the capabilities of a modern PCB processor (**Reference 10**). In addition to the old high-tech-like flex circuits, a host of improvements make a new set of high-tech-PCB designs that are truly hot technologies. EDN

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designideas

READERS SOLVE DESIGN PROBLEMS

Circuit provides more accurate multiplication

Yakov Velikson, Lexington, MA

Common analog multiplying devices employ methods using transistor parameters. Precise versions of these devices use the logarithm method of multiplication. This method involves the addition of logarithms and an exponential conversion (**Reference 1**). Using these methods, you can achieve a minimal error of ±0.1%. This Design Idea reduces the error, employs readily available standard components, and maintains the correct voltage scale.

The structure squares the sum and the difference of both components of the desired multiplication. The difference of these squared values yields the result of the multiplication. You can scale the desired multiplication of a and b using the identity of $4ab=(a+b)^2-(a-b)^2$. In a conceptual diagram, blocks 1 and 2 represent the input part of the device (**Figure 1**). They comprise identical precise rectifiers. You implement these rectifiers with amplifiers A_1, A_2, A_3, and A_4 (**Figure 2**). They provide the addition and the subtraction of input voltages V_A and V_B. The rectifiers create the output voltages $k(V_A+V_B)$, $k(V_A-V_B)$, which have only positive polarity. You connect these outputs to a two-channel ADC, Block 3, and then to two identical DACs: DAC_1 (Block 4) and DAC_2 (Block 5).

The ADC converts $k(V_A+V_B)$ and $k(V_A-V_B)$ to proportional codes N_1 and N_2. The ADC must handle the conversion over the full range of the absolute sum $|k(V_A+V_B)|$. The reference voltage of the ADC should be equal to the maximum expected value of $|k(V_A+V_B)|$. Codes N_1 and N_2 translate to Register 1 of DAC_1 and Register 2 of DAC_2, respectively (**Reference 2**). These codes establish the values on the R–2R dividers of each DAC. The output voltages of blocks 4 and 5, comprising $N_1|k(V_A+V_B)|$ and $N_2|k(V_A-V_B)|$, pass through operational amplifier A_7 in Block 6. You configure the op amp with a differential input, which takes the difference between the inputs and creates the multiplication result on the output. For example, if both voltages V_A and V_B have a range of ±10V and the input range of the ADC is 0 to 10V, then coefficient $k=R_2/R_1=0.5$. The full sum of each part should be ±10V. **Table 1** provides the results for all four quadrants of these conditions.

The systematic error of the multiplication is the sum of the discrete errors

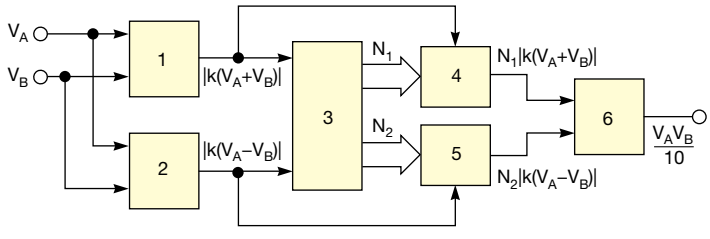

Figure 1 Perform a multiplication of two values, V_A and V_B, by using ADCs, DACs, and amplifiers to do the mathematics of an equivalent expression.

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TABLE 1 RESULTS OF FOUR QUADRANTS

V_A (V)	V_B (V)	$k(V_A+V_B)$ (V)	$k(V_A-V_B)$ (V)	N_1	N_2	V_5 (V)	V_6 (V)	V_5-V_6 (V)
5	3	4	1	0.4	0.1	–1.6	–0.1	1.5
5	–3	1	4	0.1	0.4	–0.1	–1.6	–1.5
–5	3	1	4	0.1	0.4	–0.1	–1.6	–1.5
–5	–3	4	1	0.4	0.1	–1.6	–0.1	1.5

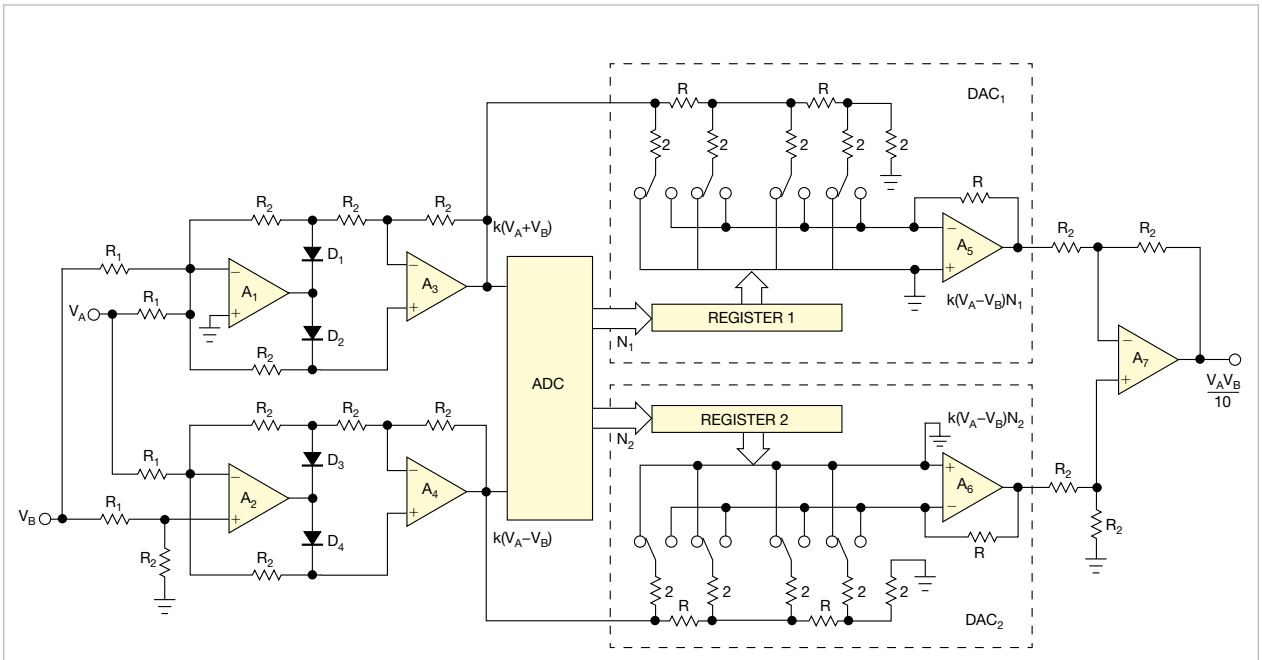

Figure 2 The detailed schematic of the multiplier follows the block diagram of Figure 1.

of the ADC and both DACs. This error depends on the resolutions of these devices. Choosing an ADC and DACs with greater resolutions will further reduce the overall error. EDN

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A few added components make a self-contained controller for 100A load

Steve Hageman, AnalogHome.com, Windsor, CA

The late Jim Williams' last project was a 100A active load (**Reference 1**). That design needed a separate signal generator and other components. This Design Idea makes the load self-contained. It adds potentiometers to control the stepped load levels, a chopper oscillator to switch between the set load levels, and a dual-readout DPM (digital-panel meter) to allow for direct voltage and current readout. In tribute to Williams, it uses three Linear Technology chips.

The heart of the load controller is two potentiometers, Set A and Set B (**Figure 1**). These devices allow you to set A and B load levels anywhere in the 0 to 100A-load-range capability of Williams' design. For instance, assume that Set A is at –0.5V and Set B is at –0.75V. Switching the load between these two levels changes it from 50 to 75A. Timer chip IC_1 controls the stepping rate and duty cycle between the Set A and the Set B levels. This timer IC allows you to control frequency over a decade range. It also allows you to set the duty cycle between 0 and 100%.

The full 0 to 100% duty-cycle control comes in handy when you set up the load. At 100% duty cycle, the voltage between the potentiometers does not switch, and the Set A control is active alone. This situation allows you to adjust Set A and watch the actual dc level on the dual-readout panel meter. Likewise, setting the duty-cycle control to 0% switches to the Set B potentiometer and allows you to adjust its static or dc level.

THE FULL 0 TO 100% DUTY-CYCLE CONTROL COMES IN HANDY WHEN YOU SET UP THE LOAD.

Setting any duty cycle other than 0 or 100% causes the Set A and Set B levels to alternate. You control the chopping frequency by adjusting the fre-

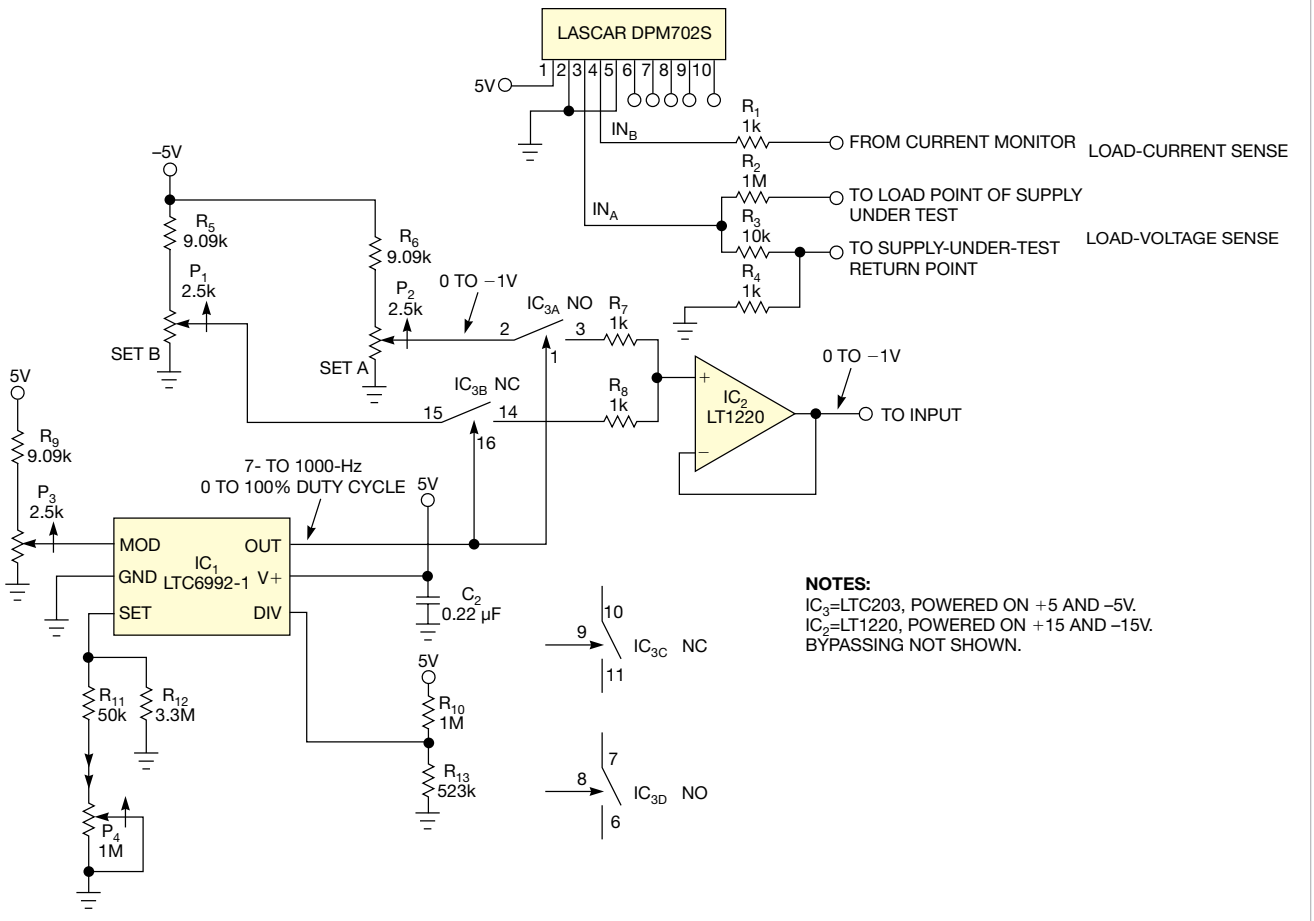

Figure 1 Adding this circuit to a 100A active load makes a stand-alone piece of test equipment.

quency potentiometer, P_4. A frequency of 60 to 1000 Hz best suits use in large power supplies. You can adjust the values of the resistors to get chopping frequencies of 4 Hz to 1 MHz.

Take care with the physical mounting of potentiometer P_4. Any stray capacitance on the Set pin of IC_1 is detrimental to its proper operation. Resistors R_{11} and R_{12} should be placed next to IC_1. You can wire potentiometer P_3 a few inches away for panel mounting.

Connect the labeled points in **Figure 1** directly to the labeled points in Williams' original schematic. You should change the 51Ω resistor at the earlier circuit's Input pin to something on the order of 1 kΩ. IC_2 should be close to the previous design's A_1 amplifier. You can slightly optimize the pulse's shape if necessary by adjusting the 300-pF capacitor at the input to A_1 on the original design.

The dual-readout DPM from Lascar Electronics is handy in active-load applications (**Reference 2**). The dual 3½-digit voltmeter has a ±1.999V input and has built-in annunciations for amperes and volts. Set the decimal place to the proper location by soldering jumper pads on the back of the unit.

This design connects the voltmeter across the load terminals but doesn't compensate for voltage drop on the leads connecting the load to the power supply. At the 100A level, the voltmeter doesn't provide the kind of accuracy that load-regulation testing requires. The voltage indication at the load is useful, however. It provides adequate indication that the power supply under test is still regulating and that the test leads connect properly to the load. If you need a more accurate reading, it is a simple matter to connect a 6½-digit bench DMM (digital multimeter) directly to the power supply under test. EDN

REFERENCES

1 Williams, Jim, "Design a 100A active load to test power supplies," *EDN*, Sept 22, 2011, pg 28, http://bit.ly/sGqlY5.
2 Lascar Electronics, www.lascarelectronics.com.

Simple night-light uses a photoresistor to detect dusk

Chau Tran, Analog Devices, Malden, MA

Streetlights, emergency lights, and security lights must automatically turn on when it gets dark. You base the control circuit on the resistance of a photoresistor or another LDR (light-dependent resistor) that varies with light intensity. An LDR's resistance of several megohms in darkness decreases to a few hundred ohms in bright light (**Figure 1**). This feature allows a circuit to distinguish between one light bulb and two, direct sunlight or total darkness, or anything in between.

You can use an LDR in a circuit that detects darkness and turns on an LED (**Figure 2**). The circuit uses a high-voltage threshold-detector IC that features a current output and operates as a comparator. The LDR and potentiometer R_3 form one side of a Wheatstone bridge. Fixed resistors R_1 and R_2 form the other side. You can operate the circuit from a 5 to 65V battery because the bridge excitation comes from an on-chip 2.4V series regulator that is referenced to the supply voltage. The chip keeps the 2.4V regulation voltage below the supply voltage. Resistors R_1 and R_2 form a fixed reference voltage at the noninverting input of internal comparator A_1. The LDR and R_3 form a variable voltage at the inverting input. When the light level falls, the voltage on the inverting input falls below the reference voltage until the comparator trips, activating the relay and the LED. The total voltage across the resistors is always 2.4V. Choose the values for these resistors based on your desired threshold voltage using the **equation** $V_{TH}=-2.4\times(R_1/(R_1+R_2))=-2.4\times(LDR/(R_3+LDR))$, where V_{TH} is the threshold voltage.

YOU CAN ADJUST THE POTENTIOMETER TO PRESET THE SWITCH TO ANY LIGHT LEVEL, MAKING IT AN IDEAL LIGHT SENSOR.

You can reverse the position of the LDR and potentiometer R_3 to switch on the relay when the light exceeds a preset level. You can adjust the potentiometer to preset the switch to any light level, making it an ideal light sensor. The IC's output current is less than 100 nA when the negative pin's value is greater than that of the positive pin. The output current goes to 1 mA when the positive pin's value is greater than that of the negative pin. This current drives a ground-referenced resistor to develop a logic-level signal at D_{OUT}. The logic signal is buffered with the NPN transistor that then drives relay switch S_1. You should use a latching relay, which uses permanent magnets to hold the armature in place after the drive current is removed.

When you turn on the LED, the resistance of the LDR may decrease dramatically, and the comparator will switch off, cutting back the output current to nanoamps while the latching relay keeps the light on. EDN

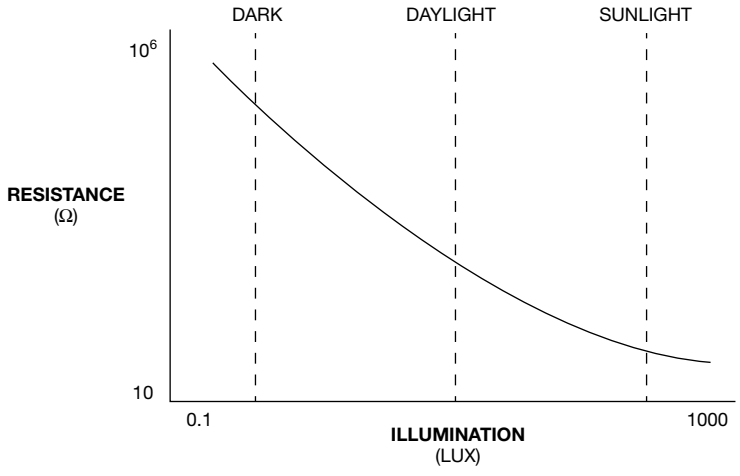

Figure 1 The resistance of a photoresistor falls dramatically as you illuminate it.

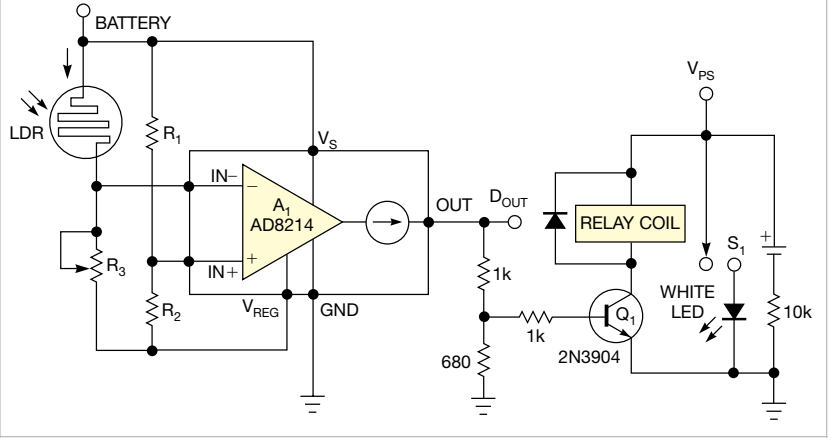

Figure 2 This night-light circuit turns on as the illumination on the photoresistor dims.

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Originally published in the December 23, 1999, issue of *EDN*

Simple tester checks Christmas-tree lights

William Dias, Brown & Sharpe, North Kingstown, RI

Why is it that you always test 48 bulbs before you find the bad one in a 50-light string? The simple circuit in **Figure 1** allows you to divide and conquer, greatly reducing the time it takes to find the bad bulb. The circuit uses a pair of NE2 neon bulbs with current-limiting resistors. You can use a pair of Radio Shack 272-1100 bulb-resistor sets. It's convenient to house the tester in a clear piece of plastic tubing, with the probe tip emerging from one end and a light-duty power cord emerging from the other end. You place the bulbs in the tube such that one is close to the probe tip and the other is near the power cord, so it's easy to remember which bulb lit last. The probe tip connects to the common point between the neon bulbs. It consists of thin spring wire with all but the last ¼ in. insulated. You use the bare tip to make contact with the crimp connectors in the base of the bulbs.

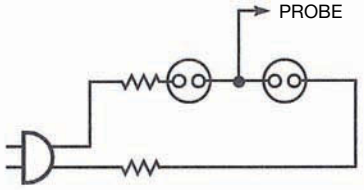


Figure 1 A simple probe set cuts the time you spend troubleshooting a series-string light set.

Series-string Christmas-tree lights come in two types. The first type is the continuous-series string (**Figure 2a**). In this configuration, one wire from the plug goes from bulb to bulb until it reaches the last bulb. A return wire bypasses all the bulbs and returns to the plug. The second type is the alternating-series string (**Figure 2b**). In this connection, one wire from the plug goes to the first bulb, and the other wire from the plug goes to the second bulb. The connections then alternate through the string. To troubleshoot a defective continuous-series string:

- Plug in both the tester and the bulb set.
- Insert the tip of the tester's probe into the wire hole in the base of the first bulb. One of the neon bulbs should light; remember which one.
- Move halfway down the set and insert the probe again. If the same neon bulb lights, then the problem is in the second half of the set. If the other neon bulb lights, then the problem is in the first half of the set. Either way, you are testing 25 of the 50 bulbs without breaking into a sweat.
- If the original neon bulb lights, move halfway down the remaining part of the set and try again. If the other neon bulb lights, you must move back halfway to the last bulb you tested and try again. This process should allow you to find a bad bulb in a set of 50 in only seven steps. You know you have the bad bulb when inserting the probe tip into one side of the bulb lights one neon bulb and placing the tip in the other side lights the other neon bulb.

To troubleshoot a defective set with many bad bulbs, use the same process as above. At some point, you will reach the dead spot between two or more bad bulbs. When you reach this point, neither neon lamp will light. Back up, just as if the other neon bulb had lit. You know you have a bad bulb if the probe lights when you plug it into one side and nothing lights when you plug it into the other side. Replace this bulb and start over.

To troubleshoot an alternating-series string, you must work in pairs. Test the first bulb, and one neon bulb lights. Test the second bulb, and the other neon bulb lights. Now move down the set an even number of lights and test the next pair of lights. When you pass the bad bulb, the same neon lamp lights for both series-string bulbs. EDN

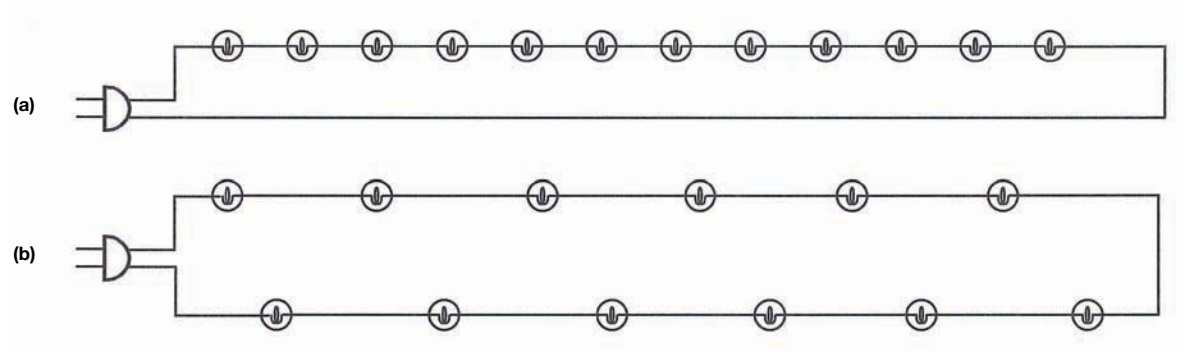


Figure 2 Series-string light sets come in two flavors: a continuous-series string (a) and an alternating-series string (b).

productroundup

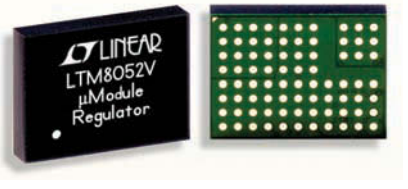
POWER SOURCES

IR's IRS2980 LEDrivIR aims at nonisolated LED-driver applications

The 600V IRS2980 buck-regulator-control IC targets applications in LED-light-bulb replacement, LED-tube lighting, and other nonisolated LED-driver applications. The device uses hysteretic average-current-mode control for precise current regulation. The LED buck driver features low-side MOSFET drive with a high-voltage internal regulator and high-side current sensing. The converter is compatible with electronic PWM dimming, allowing for 0 to 100% current control. The IRS2980 is available in an SO-8 package at prices starting at 60 cents (10,000).
International Rectifier, www.irf.com

Linear LTM8052 µModule has adjustable output-current limit

The 36V-input-voltage, constant-frequency, step-down LTM8052 µModule regulator has an adjustable current limit as high as 5A, helping designers set the maximum power a load receives and minimizing the output rating of the upstream ac/dc- or dc/dc-power supply. The device can source or sink current while regulating an adjustable output voltage. It operates at a constant frequency throughout the entire output-current range. The regulator converts an input voltage of 6 to 36V to an adjustable output voltage of 1.2 to 24V. In a 12V-input to 2.5V-output application, the LTM8052 achieves a peak operating efficiency of 88% at 2A. The device has a ±10% adjustable-current-limit accuracy, can synchronize to an external 100-kHz to 1-MHz clock, and comes in an 11.25×15×2.82-mm LGA package. Prices start at $13.17 (1000).
Linear Technology,
www.linear.com



ZMDI announces ZSSC1856 intelligent battery sensor

The ZSSC1856 intelligent battery-sensor IC for fuel-saving start/stop systems measures state of health, state of charge, and state of function of a vehicle's battery. A calibrated on-chip temperature sensor eliminates the need for calibration of external components. The device also features user-controlled wake-up conditions. An ARM core, a 96-kbyte flash/electronically erasable memory with ECC, and an 8-kbyte SRAM are available to execute customer-specific software for calculating the battery states. The ZSSC1856 uses less than 100 µA in sleep mode and operates with 10 to 20 mA in normal mode. The IC can

receive voltages of 4.2 to 18V and directly connects to the vehicle's battery. The IC comes in a 5×5-mm, 0.85-mm-high QFN32 package and sells for $5.40 (low volumes).
ZMDI, www.zmdi.com

Infineon unveils ILD series of high-power LED-driver ICs

The ILD series of switch-mode, high-power LED-driver ICs combines an integrated power stage and an external MOSFET to achieve efficiency as high as 98% in MR16 halogen retrofits, residential and commercial lumi-

naires, architectural lighting, and streetlamps. The ILD2035 finds use in MR16 lamps with 1W LEDs, and a stand-alone LED controller includes the features and protection functions of the ILD4001, which uses an external MOSFET as a power stage. The ILD4001, ILD4035, and ILD2035 come in SC-74 packages, and the ILD4120 comes in a DSO-8 package with an exposed pad. Input voltages range from 4.5 to 42V for the ILD4001 and 4.5 to 40V for the ILD4035 and ILD4120. The ILD4035 sells for 60 cents (10,000).
Infineon Technologies AG,
www.infineon.com

TDK offers splash-proof AL60-100 LED drivers/supplies

The AL60-100 series of ac/dc power supplies targets use in LED lighting, signs, and displays with output ratings of 60, 80, and 100W. Both constant-voltage and constant-current models are available. The drivers and supplies include PFC and meet IP66 standards for

EDN ADVERTISER INDEX

splash-proof supplies and operate with universal power inputs of 90 to 305V ac with no derating at low line. The constant-voltage models are available with 12, 24, or 36V outputs; the constant-current units provide 1 to 4A with dc outputs of 6 to 48V. The convection-cooled devices can operate with ambient temperatures of –30 to +70°C and deratings higher than 50°C. Typical output efficiencies are 85 to 90% under full load. The devices come in rugged plastic cases that measure 1.36×1.7×9.49 in. Prices start at $42 (1000).

TDK-Lambda Americas, **www.us.tdk-lambda.com**

IR's AUIRS2332J targets use in EV, HEV applications

The 600V, three-phase AUIRS2332J MOSFET- and IGBT-gate-driver IC for high-voltage EV (electric-vehicle) and HEV (hybrid-electric-vehicle) applications features three independent high- and low-side-referenced output channels. Proprietary HVIC technology enables ruggedized monolithic construction with logic inputs compatible with CMOS or LSTTL outputs, down to 3.3V logic. The IC comes in a PLCC-44 package, providing higher creepage distances between high-voltage pins and simplifying PCB layout. The device has an offset voltage of 600V, an output voltage of 10 to 20V, an output current of 250 or –500 mA, and on- and off-times of 540 nsec. Matched propagation delays simplify use at high frequencies. Designers can use the floating channel to drive N-channel power MOSFETs or IGBTs in the high-side configuration. Prices begin at $3.34 (10,000).

International Rectifier, **www.irf.com**

Fairchild's PSW creates flyback-power-supply circuits in minutes

The PSW (Power Supply WebDesigner) online simulation tool allows designers to create a flyback design, including the selection of a controller, a MOSFET, diodes, transformers, snubber circuits, output filters, ac input circuits, resistors, and capacitors. Alternatively, the tool can automatically recommend the design values, providing the vendor's part numbers if applicable. PSW includes steady-state and transient waveforms and loop-gain plots showing stability margins. It also includes a BOM, a distributor parts order, and simulation features that help designers fine-tune their designs without building a bench prototype. The PSW tool is free to registered customers.

Fairchild Semiconductor, **www.fairchildsemi.com**

CUI's VSK encapsulated ac/dc modules operate at 5 to 25W

The board-mounted, 5 to 25W VSK encapsulated ac/dc power-supply modules measure 2×1×0.6 in. in the 5W package. Efficiency is 87%, and operating-temperature range is –25 to +70°C. The devices provide continuous output power; a universal input of 85 to 264V ac; and fully regulated dc outputs of 3.3, 5, 9, 12, 15, 24, and 48V dc. The

5 and 10W versions have 4-kV-ac isolation, and the 15, 20, and 25W versions have 3-kV-ac isolation. Prices start at $13.56 (100).

CUI Inc, **www.cui.com**

It's a bird! It's a crane!

At our corporate offices, we started getting alarms on our microwave terminal, which supplied the communications link for the telephones and data. The chief executive officer was upset over losing his calls at various times, so I was assigned to find the cause of this problem and fix it PDQ! The alarms would start at approximately 9 a.m. and would occur intermittently all day long for a few seconds and then stop at about 4 p.m. I went to the corporate offices, checked the radio equipment, and found no problems. I even looked for a fault in the alarms circuitry. I found the radio equipment to be functioning properly. All levels, power, and voltages were within specifications. I arrived the next day at 7 a.m. and started to monitor this equipment, hoping to find the problem. Sure enough, at 8:53, the alarm lights on the equipment lit up like a Christmas tree. Before I could even begin to check anything, the alarms went out.

I remained at my post, and, in about 20 minutes, the alarms went off and again lasted for only a few seconds. It now became obvious that we were experiencing a path loss. What was blocking the signal path in both directions for just a few seconds? Could it be a flock of birds? Airplanes flying by?

I tried to detect a pattern of this loss by timing the periods between the losses. Whenever I thought I had found a cadence to the failures, however, they would change. The only pattern I did find was that the failures ceased between 12 noon and 12:45 p.m. That discovery was telling me something, but what? Was it telling me that it was lunchtime? If so, I wondered how lunchtime figures into a path loss. I ran through all the options I could think of that could be causing this trouble: a helicopter flight above the path, laser sighting between the dishes, vehicles driving around the path area, and so on.

Pondering these things, I opened a window to have a smoke. While looking at the view from this 10th-floor perch, I noticed a glimmer reflecting from something just as the alarms went off. Was there a connection between the glimmer and the alarms?

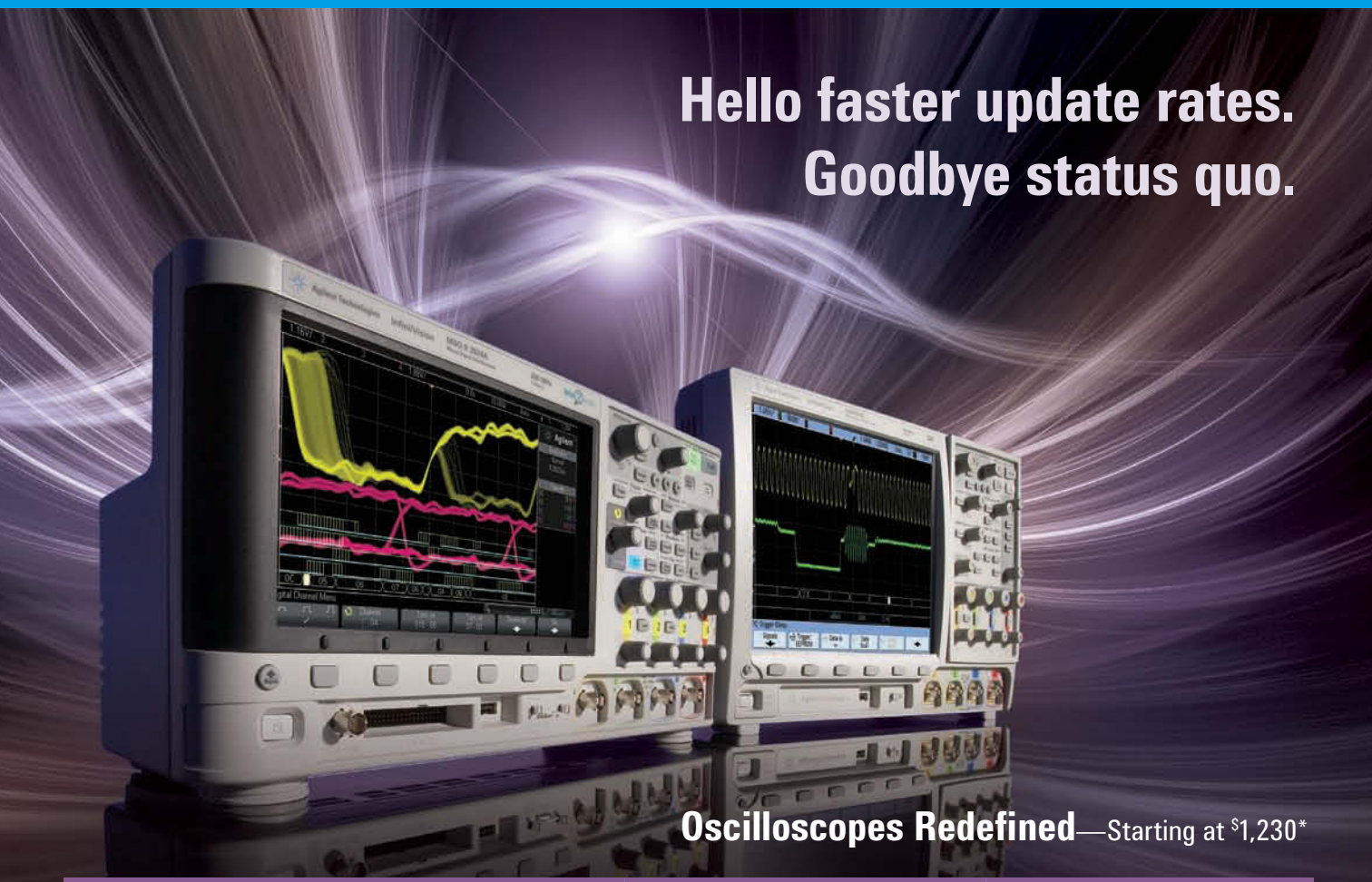
I remained at the window, checking the horizon and again saw the glimmer, and the alarms again went off. I tried to identify a landmark where I saw the glimmer and proceeded down to my vehicle and drove to the area of the landmark. As I approached the landmark, I saw a construction site with a huge crane, lifting steel up to a multistory building under construction. I remained at this location, and, as the crane lifted a steel girder, I called the office and had them monitor the alarms while I watched the crane. Sure enough, the office verified a failure. I stayed where I was, and the failures again coincided with the crane lifts. I realized that, when construction was complete, we would have no path at all. This new building—ironically, a communications company—would permanently block our path.

Our only choice was to find another path through the city to the microwave hub—an impossible task. So we came up with a temporary solution: using a passive dish system on top of another building, placing the dishes back to back, turning one dish toward the microwave hub, and turning the other one toward our building. We mounted two new dishes on the roof of an adjacent building, aiming one at the distant hub's location and tying it, through a waveguide, to a dish pointing at our building's dish. Getting enough signal to pass between these two dishes without any amplification was a major challenge. The alignment of the dishes on the buildings proved difficult at these low signal levels. EDN

Earl Schlenk is a retired engineer for Burlington Northern Railroad. He resides in St Louis, MO.

DANIEL VASCONCELLOS

Hello faster update rates. Goodbye status quo.



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Max. update rate	50,000	200*	1,000,000	5,000	100,000	50,000
Screen size	8.5 in.	5.7 in.	8.5 in.	7 in.	12.1 in.	10.4 in.
Fully upgradable	Yes	No	Yes	No	MSO only	No
Function generator	Yes	No	Yes	No	No	No

Data References: Refer to Agilent pub 5989-7885EN for update rate measurements. Data for competitive scopes from publications 3GW-25645-1, 3GW-22048-1, and 3GW-20156-10.
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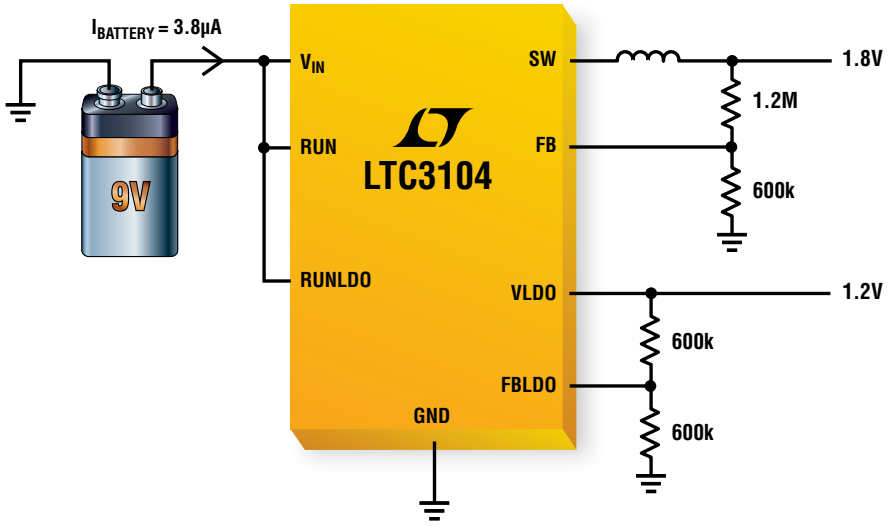
Change Batteries in 2018



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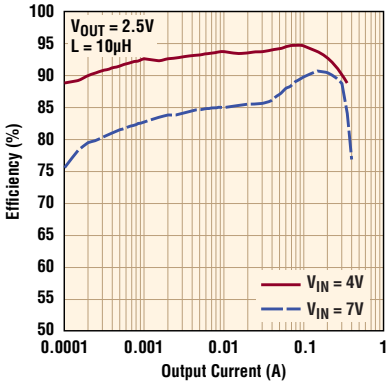

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LTC3104 Video Product Brief

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